

PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau



INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A61K 38/12, C07K 7/56		A1	(11) International Publication Number: WO 96/31228
			(43) International Publication Date: 10 October 1996 (10.10.96)
(21) International Application Number: PCT/US96/04543 (22) International Filing Date: 3 April 1996 (03.04.96) (30) Priority Data: 08/418,341 7 April 1995 (07.04.95) US (60) Parent Application or Grant (63) Related by Continuation 08/418,341 (CON) Filed on 7 April 1995 (07.04.95) (71) Applicant (for all designated States except US): ELI LILLY AND COMPANY [US/US]; Lilly Corporate Center, Indianapolis, IN 46285 (US). (72) Inventors; and (75) Inventors/Applicants (for US only): BORROMEIO, Peter, S. [US/US]; 10783 Thistle Ridge, Fishers, IN 46038 (US). JAMISON, James, A. [US/US]; Apartment 1C, 6711 Eagle Pointe Drive North, Indianapolis, IN 46254 (US). RODRIGUEZ, Michael, J. [US/US]; 1827 Sailing Court, Indianapolis, IN 46260 (US). TURNER, William, W., Jr. [US/US]; 4000 Saratoga Drive, Bloomington, IN 47401			(US). VASUDEVAN, Venkatraghavan [IN/US]; 1016 Saratoga Circle, Indianapolis, IN 46280 (US). (74) Agents: McCLAIN, Janet, T. et al.; Eli Lilly and Company, Lilly Corporate Center, Indianapolis, IN 46285 (US). (81) Designated States: AL, AM, AU, AZ, BB, BG, BR, BY, CA, CN, CZ, EE, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LS, LT, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, RO, RU, SD, SG, SI, SK, TJ, TM, TR, TT, UA, UG, US, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG). Published With international search report.
(54) Title: CYCLIC PEPTIDE ANTIFUNGAL AGENTS			
(57) Abstract			
<p>Provided are pharmaceutical formulations, and methods of inhibiting fungal and parasitic activity using a compound of formula (I) wherein: R' is hydrogen, methyl or NH₂C(O)CH₂; R'' and R''' are independently methyl or hydrogen; R^{x1}, R^{x2}, R^{y1}, R^{y2}, R^{y3}, and R^{y4} are independently hydroxy or hydrogen; R₀ is a group of formula (1); R₁ is C₁-C₆ alkyl, C₁-C₆ alkoxy, phenyl, p-halo-phenyl, p-nitrophenyl, phenoxy, benzyl, p-halo-benzyl, or p-nitro-benzyl; and R₂ is an acyl side chain as defined herein.</p>			
<p style="text-align: right;">(I)</p>			
<p style="text-align: right;">(1)</p>			

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AM	Armenia	GB	United Kingdom	MW	Malawi
AT	Austria	GE	Georgia	MX	Mexico
AU	Australia	GN	Guinea	NE	Niger
BB	Barbados	GR	Greece	NL	Netherlands
BE	Belgium	HU	Hungary	NO	Norway
BF	Burkina Faso	IE	Ireland	NZ	New Zealand
BG	Bulgaria	IT	Italy	PL	Poland
BJ	Benin	JP	Japan	PT	Portugal
BR	Brazil	KE	Kenya	RO	Romania
BY	Belarus	KG	Kyrgyzstan	RU	Russian Federation
CA	Canada	KP	Democratic People's Republic of Korea	SD	Sudan
CF	Central African Republic	KR	Republic of Korea	SE	Sweden
CG	Congo	KZ	Kazakhstan	SG	Singapore
CH	Switzerland	LI	Liechtenstein	SI	Slovenia
CI	Côte d'Ivoire	LK	Sri Lanka	SK	Slovakia
CM	Cameroon	LR	Liberia	SN	Senegal
CN	China	LT	Lithuania	SZ	Swaziland
CS	Czechoslovakia	LU	Luxembourg	TD	Chad
CZ	Czech Republic	LV	Latvia	TG	Togo
DE	Germany	MC	Monaco	TJ	Tajikistan
DK	Denmark	MD	Republic of Moldova	TT	Trinidad and Tobago
EE	Estonia	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	UG	Uganda
FI	Finland	MN	Mongolia	US	United States of America
FR	France	MR	Mauritania	UZ	Uzbekistan
GA	Gabon			VN	Viet Nam

-1-

CYCLIC PEPTIDE ANTIFUNGAL AGENTS

5 This invention relates to semi-synthetic cyclic peptide compounds which are useful as antifungal and antiparasitic agents and which have improved stability and water solubility. In particular, it relates to derivatives of the echinocandin class of cyclic peptides; to methods for treating fungal and parasitic infections, and to formulations useful in the methods.

10 The compounds provided by this invention are semi-synthetic compounds derived from cyclic peptides which are produced by culturing various microorganisms. A number of cyclic peptides are known in the art including echinocandin B (A30912A), aculeacin, mulundocandin, sporiofungin, L-671,329, and S31794/F1.

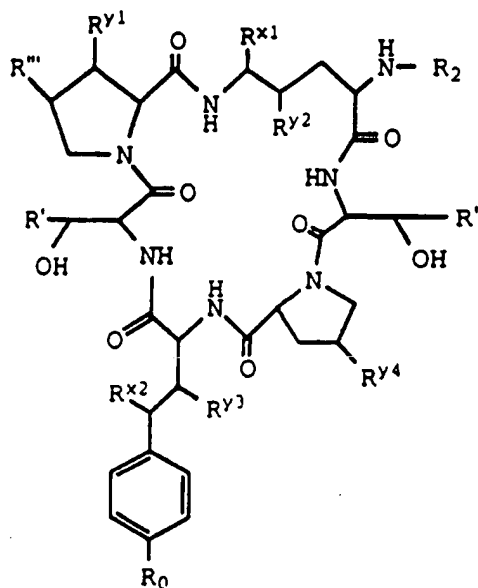
15 In general, these cyclic peptides may be structurally characterized as a cyclic hexapeptide core (or nucleus) with an acylated amino group on one of the core amino acids. The amino group is typically acylated with a fatty acid group forming a side chain off the nucleus. For example, echinocandin B has a linoleoyl side chain while aculeacin has a palmitoyl side chain.

20 The fatty acid side chains may be removed from the cyclic peptide core to provide an amino nucleus (for example, a compound of formula I, below, where R_2 is hydrogen). The amino group may then be re-acylated to provide semi-synthetic compounds such as those claimed in the present application.

25 The echinocandin B nucleus has been re-acylated with certain non-naturally occurring side chain moieties to provide a number of antifungal agents (see, Debono, U.S. Pat. No. 4,293,489). Among such antifungal agents is cilofungin which is represented by a compound of formula I where R' , R'' , and R''' are methyl; R^{x1} and R^{x2} are hydroxy, R^{y1} , R^{y2} , R^{y3} , R^{y4} are hydroxy, R_0 is hydroxy, and R_2 is p-(octyloxy)benzoyl.

-2-

The present invention provides a compound of formula I:



I

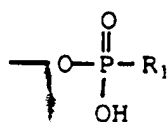
5 wherein:

R' is hydrogen, methyl or $\text{NH}_2\text{C}(\text{O})\text{CH}_2-$;

R'' and R''' are independently methyl or hydrogen;

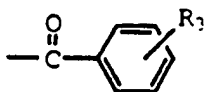
Rx1, Rx2, Ry1, Ry2, Ry3, and Ry4 are independently hydroxy or hydrogen;

10 R_0 is a group of the formula



R₁ is C₁-C₆ alkyl, C₁-C₆ alkoxy, phenyl, p-halo-phenyl, p-nitrophenyl, phenoxy, benzyl, p-halo-benzyl, or p-nitro-benzyl;

I) R_2 is a group of the formula



20 where:

A) R₃ is C₁-C₁₂ alkyl, C₁-C₆ alkoxy or quinolyl;

-3-

B) R_3 is $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$;

m and n are independently 2, 3 or 4;

p is 0 or 1; or

C) R_3 is $-Y-(C_1-C_{12} \text{ alkyl})$;

5 Y is $-C\equiv C-$ or $-CH=CH-$; or

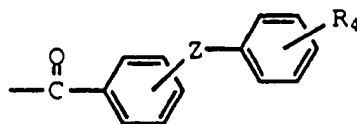
D) R_3 is $-O-(CH_2)_q-G$;

q is 2, 3 or 4;

G is C_7-C_{10} bicycloalkyl or C_7-C_{14} tricycloalkyl; or

10

II) R_2 is a group of the formula



where:

15 Z is $-O-$, $-C\equiv C-$, $-CH=CH-$, $-CH_2-CH_2-$, $-CH_2-$, or a bond;

A) R_4 is hydrogen, C_1-C_{12} alkyl, C_1-C_{12} substituted alkyl, C_2-C_{12} alkenyl, C_2-C_{12} substituted alkenyl, C_2-C_{12} alkynyl, C_2-C_{12} substituted alkynyl, C_1-C_{12} alkoxy, C_3-C_{12} cycloalkyl, C_7-C_{10} bicycloalkyl, C_7-C_{14} tricycloalkyl, C_3-C_{12} cycloalkoxy, naphthyl, pyridyl, thienyl, benzothienyl, quinolyl or phenyl; or

20

B) R_4 is phenyl substituted by amino, C_1-C_{12} alkylthio, halo, C_1-C_{12} alkyl, C_2-C_{12} alkenyl, C_2-C_{12} alkynyl, C_1-C_{12} substituted alkyl, C_2-C_{12} substituted alkenyl, C_2-C_{12} substituted alkynyl, C_1-C_{12} alkoxy, trifluoromethyl, phenyl, substituted phenyl, or phenyl substituted with a group of the formula $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$ where m , n and p are as defined above; or

25

30

C) R_4 is C_1-C_{12} alkoxy substituted with halo, C_3-C_{12} cycloalkyl, C_7-C_{10} bicycloalkyl, C_7-C_{14} tricycloalkyl, C_1-C_6 alkoxy, C_2-C_{12} alkynyl, amino, C_1-C_4 alkylamino,

-4-

di(C₁-C₄ alkyl)amino, formamido, C₂-C₁₂ alkanoylamino, or phenyl substituted with a group of the formula -O-(CH₂)_m-[O-(CH₂)_n]_p-O-(C₁-C₁₂ alkyl) where m, n and p are as defined above; or

5

D) R₄ is -O-(CH₂)_r-W-R₅;

r is 2, 3 or 4;

W is pyrrolidino, piperidino or piperazino;

10 R₅ is hydrogen, C₁-C₁₂ alkyl, C₃-C₁₂ cycloalkyl, benzyl or C₃-C₁₂ cycloalkylmethyl; or

E) R₄ is -Y¹-R₆;

Y¹ is -C≡C- or -CH=CH-;

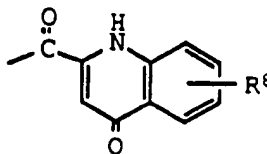
15 R₆ is C₃-C₁₂ cycloalkyl, C₇-C₁₀ bicycloalkyl, C₇-C₁₄ tricycloalkyl, C₃-C₁₂ cycloalkenyl, naphthyl, benzothiazolyl, thienyl, indanyl, fluorenyl, or phenyl substituted with C₁-C₁₂ alkylthio, C₂-C₁₂ alkenyl, C₂-C₁₂ alkynyl, halo(C₁-C₆ alkoxy) or a group of the formula -O-(CH₂)_r-W-R₅ where r, W and R₅ are as defined above; or

20 R₆ is phenyl substituted with a group of the formula -O-(CH₂)_m-[O-(CH₂)_n]_p-O-(C₁-C₁₂ alkyl) where m, n and p are as defined above; or

25 F) R₄ is C₁-C₁₂ alkoxy substituted with a group of the formula -NHC(O)R₇;

R₇ is C₁-C₆ alkoxy, or phenyl(C₁-C₆ alkoxy); or

III) R₂ is a group of the formula

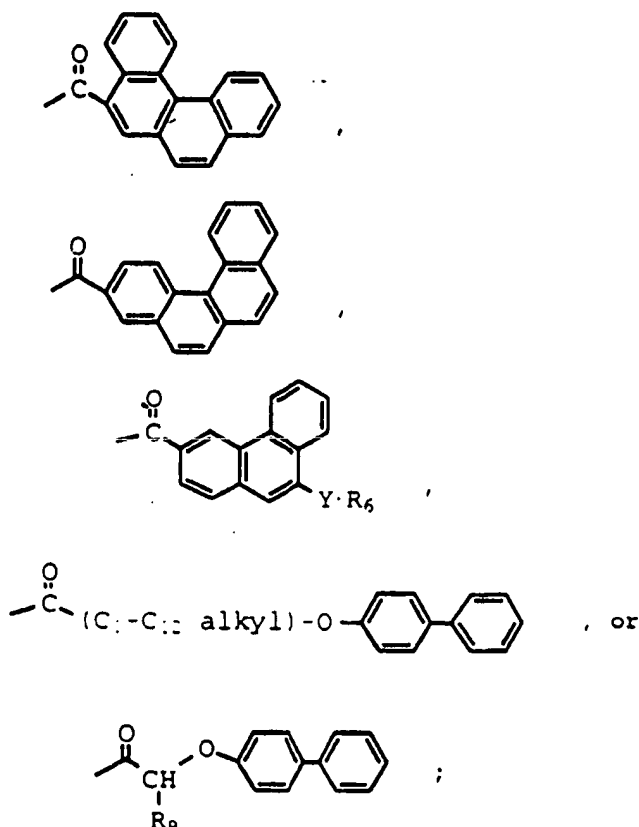


30

where R⁸ is C₁-C₁₂ alkoxy or a group of the formula -O-(CH₂)_m-[O-(CH₂)_n]_p-O-(C₁-C₁₂ alkyl) where m, n and p are as defined above; or

-5-

IV) R_2 is a group of the formula



where:

5

Y and R_6 are as defined above;

R_9 is phenyl, C_1 - C_{12} alkyl, or C_1 - C_{12} alkoxy; or

V) R_2 is naphthoyl substituted with R_4 where R_4 is as defined above;

10 or a pharmaceutically acceptable salt thereof.

Also provided are pharmaceutical formulations, methods for inhibiting parasitic or fungal activity and methods of treating fungal or parasitic infections which employ the compounds of the invention.

15

As used herein, the term " C_1 - C_{12} alkyl" refers to a straight or branched alkyl chain having from one to twelve carbon atoms. Typical C_1 - C_{12} alkyl groups include methyl, ethyl, propyl, isopropyl, butyl, sec-butyl, t-butyl, pentyl, 5-methylpentyl, hexyl, heptyl, 3,3-

20

-6-

dimethylheptyl, octyl, 2-methyl-octyl, nonyl, decyl, undecyl, dodecyl and the like. The term "C₁-C₁₂ alkyl" includes within its definition the terms "C₁-C₆ alkyl" and C₁-C₄ alkyl."

5 The term "halo" refers to chloro, fluoro, bromo or iodo.

 The term "C₂-C₁₂ alkenyl" refers to a straight or branched alkenyl chain having from two to twelve carbon atoms. Typical C₂-C₁₂ alkenyl groups include ethenyl, 1-
10 propen-2-yl, 3-buten-1-yl, 1-buten-2-yl, 1-buten-1-yl, 1-penten-3-yl, 2-hexen-3-yl, 1-decen-2-yl, 2-decen-5-yl and the like.

 The term "C₂-C₁₂ alkynyl" refers to a straight or branched alkynyl chain having from two to twelve carbon
15 atoms. Typical C₂-C₁₂ alkynyl groups include ethynyl, 1-propyn-1-yl, 1-propyn-2-yl, 1-butyn-1-yl, 1-butyn-3-yl, 1-pentyn-3-yl, 4-pentyn-2-yl, 1-hexyn-3-yl, 3-hexyn-1-yl, 5-methyl-3-hexyn-1-yl, 5-octyn-1-yl, 7-octyn-1-yl, 4-decyn-1-yl, 6-decyn-1-yl and the like.

20 The term "C₁-C₁₂ alkylthio" refers to a straight or branched alkyl chain having from one to twelve carbon atoms attached to a sulfur atom. Typical C₁-C₁₂ alkylthio groups include methylthio, ethylthio, propylthio, isopropylthio, butylthio, 3-methyl-heptylthio, octylthio,
25 5,5-dimethyl-hexylthio and the like.

 The term "C₁-C₁₂ alkoxy" refers to a straight or branched alkyl chain having from one to twelve carbon atoms attached to an oxygen atom. Typical C₁-C₁₂ alkoxy groups include methoxy, ethoxy, propoxy, butoxy, sec-butoxy,
30 pentoxy, 5-methyl-hexoxy, heptoxy, octyloxy, decyloxy, dodecyloxy and the like. The term "C₁-C₁₂ alkyl" includes within its definition the terms "C₁-C₆ alkoxy" and C₁-C₄ alkoxy."

 The terms "C₁-C₁₂ substituted alkyl," "C₂-C₁₂
35 substituted alkenyl" and "C₂-C₁₂ substituted alkynyl," refers to the specified moiety substituted with 1 or 2 substituents independently selected from halo, hydroxy,

-7-

protected hydroxy, amino, protected amino, C₁-C₇ acyloxy, nitro, carboxy, protected carboxy, carbamoyl, carbamoyloxy, cyano, methylsulfonylamino, phenyl, substituted phenyl or C₁-C₁₂ alkoxy.

5 The term "substituted phenyl" refers to a phenyl group substituted with 1, 2 or 3 substituents independently selected from halo, hydroxy, protected hydroxy, cyano, nitro, C₁-C₁₂ alkyl, C₁-C₁₂ alkoxy, carboxy, protected
10 carboxy, carboxymethyl, hydroxymethyl, amino, aminomethyl trifluoromethyl or N-methylsulfonylamino.

 The term "C₃-C₁₂ cycloalkyl" refers a saturated hydrocarbon ring structure having from three to twelve carbon atoms. Typical C₃-C₁₂ cycloalkyl groups include cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and
15 cycloheptyl, cyclooctyl and the like.

 The term "C₃-C₁₂ cycloalkoxy" refers to a C₃-C₁₂ cycloalkyl group attached to an oxygen atom. Typical C₃-C₁₂ cycloalkoxy groups include cyclopropyloxy, cyclobutyloxy, cyclopentyloxy, cyclohexyloxy and
20 cycloheptyloxy and the like.

 The term "C₃-C₁₂ cycloalkenyl" refers to a hydrocarbon ring structure having from three to twelve carbon atoms with at least one double bond. Typical C₃-C₁₂ cycloalkenyl groups include cyclopropenyl, cyclobutenyl, cyclopentenyl and the like.
25

 The term "methyl(C₃-C₁₂ cycloalkyl)" refers to a C₃-C₁₂ cycloalkyl group that is substituted with a methyl group. Typical methyl(C₃-C₁₂ cycloalkyl) groups include 2-methylcyclopropyl, 2-methylcyclobutyl, 3-
30 methylcyclopentyl, 4-methylcyclohexyl and the like.

 The term "C₁-C₄ alkylamino" refers to a straight or branched alkylamino chain having from one to four carbon atoms attached to a nitrogen atom. Typical C₁-C₄ alkylamino groups include methylamino, ethylamino,
35 propylamino, isopropylamino, butylamino, sec-butylamino and the like.

The term "di(C₁-C₄ alkyl)amino" refers to a di(C₁-C₄ alkyl)amino chain having two straight or branched alkyl chains of from one to four carbon atoms attached to a common nitrogen atom. Typical di(C₁-C₄ alkyl)amino groups
5 include dimethylamino, diethylamino, ethylmethylamino, methylisopropyl-amino, dipropylamino, dibutylamino, methylbutylamino, *t*-butylisopropylamino, di-*t*-butylamino and the like.

The term "C₂-C₁₂ alkanoyl" represents a straight
10 or branched chain alkyl chain having from one to four carbon atoms attached to a carbonyl moiety. Typical C₂-C₁₂ alkanoyl groups include ethanoyl, propanoyl, isopropanoyl, butanoyl, isobutanoyl, sec-butanoyl, *t*-butanoyl, pentanoyl and the like.

The term "C₂-C₁₂ alkanoylamino" represents a
15 straight or branched chain alkyl group attached to a carbonylamino moiety. Typical C₂-C₁₂ alkanoylamino groups include ethanoylamino, propanoylamino, isopropanoylamino, butanoyl-amino, isobutanoylamino, sec-butanoylamino, *t*-butanoylamino, pentanoylamino and the like.
20

The terms "C₇-C₁₀ bicycloalkyl" represents two fused cycloalkyl rings having a total of seven to ten carbon atoms and "C₇-C₁₄ tricycloalkyl" represents three fused cycloalkyl rings having a total of seven to fourteen
25 carbon atoms. Typical "C₇-C₁₀ bicycloalkyl" and "C₇-C₁₄ tricycloalkyl" groups include bicyclo[2.2.1.]hept-2-yl, bicyclo[2.2.1.]hept-4-en-2-yl, bicyclo[3.3.1.]non-3-yl, bicyclo[3.3.1.]non-2-yl, bicyclo[3.2.1.]oct-2-yl, bicyclo[2.2.2.]oct-2-yl, bicyclo[2.2.2.]oct-5-en-2-yl, adamantyl and the like.
30

The term "hydroxy protecting group" refers to a substituent of an hydroxy group that is commonly employed to block or protect the hydroxy functionality while reactions are carried out on other functional groups on the
35 compound. Examples of such hydroxy protecting groups include tetrahydropyranyl, 2-methoxyprop-2-yl, 1-ethoxyethyl-yl, methoxymethyl, β -methoxyethoxymethyl,

methythiomethyl, t-butyl, t-amyl, trityl, 4-methoxytrityl, 4,4'-dimethoxytrityl, 4,4',4"-trimethoxytrityl, benzyl, allyl, trimethylsilyl, (t-butyl)dimethylsilyl, and 2,2,2-trichloroethoxycarbonyl and the like. The species of hydroxy protecting group is not critical so long as the derivatized hydroxy group is stable to the conditions of the subsequent reaction(s) and can be removed at the appropriate point without disrupting the remainder of the molecule. A preferred hydroxy protecting group is trimethylsilyl. Further examples of hydroxy protecting groups are described in T.W. Greene, "Protective Groups in Organic Synthesis," John Wiley and Sons, New York, N.Y., (2nd ed., 1991) chapters 2 and 3. The term "protected hydroxy" refers to a hydroxy group bonded to one of the above hydroxy protecting groups.

The term "dideoxy" refers to compounds of the formula I where R^{x1} and R^{x2} are each hydrogen.

The term "inhibiting", i.e. a method of inhibiting parasitic or fungal activity, includes stopping, retarding or prophylactically hindering or preventing the growth or any attending characteristics and results from the existence of a parasite or fungus.

The term "contacting", i.e. contacting a compound of the invention with a parasite or fungus, includes a union or junction, or apparent touching or mutual tangency of a compound of the invention with a parasite or fungus. However, the term does not imply any further limitations to the process, such as by mechanism of inhibition, and the methods are defined to encompass the spirit of the invention, which is to inhibit parasitic and fungal activity by the action of the compounds and their inherent antiparasitic and antifungal properties, or in other words, the compounds, used in the claimed methods are the causative agent for such inhibition.

The term "pharmaceutically acceptable salt" as used herein, refers to salts of the compounds of the above formula which are substantially non-toxic to living

-10-

organisms. Typical pharmaceutically acceptable salts include those salts prepared by reaction of the compounds of the present invention with a mineral or organic acid or an inorganic base. Such salts are known as acid addition
5 and base addition salts.

Acids commonly employed to form acid addition salts are mineral acids such as hydrochloric acid, hydrobromic acid, hydroiodic acid, sulfuric acid, phosphoric acid and the like, and organic acids such as *p*-
10 toluenesulfonic, methanesulfonic acid, oxalic acid, *p*-bromophenylsulfonic acid, carbonic acid, succinic acid, citric acid, benzoic acid, acetic acid, and the like. Examples of such pharmaceutically acceptable salts are the sulfate, pyrosulfate, bisulfate, sulfite, bisulfite,
15 phosphate, monohydrogenphosphate, dihydrogenphosphate, metaphosphate, pyrophosphate, chloride, bromide, iodide, acetate, propionate, decanoate, caprylate, acrylate, formate, isobutyrate, caproate, heptanoate, propiolate, oxalate, malonate, succinate, suberate, sebacate, fumarate,
20 maleate, butyne-1,4-dioate, hexyne-1,6-dioate, benzoate, chlorobenzoate, methylbenzoate, dinitrobenzoate, hydroxybenzoate, methoxybenzoate, phthalate, sulfonate, xylenesulfonate, phenylacetate, phenylpropionate, phenylbutyrate, citrate, lactate, γ -hydroxybutyrate,
25 glycollate, tartrate, methanesulfonate, propanesulfonate, naphthalene-1-sulfonate, naphthalene-2-sulfonate, mandelate and the like. Preferred pharmaceutically acceptable acid addition salts are those formed with mineral acids such as hydrochloric acid and hydrobromic
30 acid, and those formed with organic acids such as maleic acid and methanesulfonic acid.

Base addition salts include those derived from inorganic bases, such as ammonium or alkali or alkaline earth metal hydroxides, carbonates, bicarbonates, and the
35 like. Such bases useful in preparing the salts of this invention thus include sodium hydroxide, potassium hydroxide, ammonium hydroxide, potassium carbonate, sodium

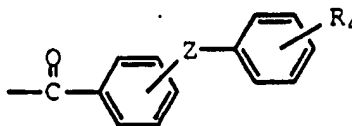
-11-

carbonate, sodium bicarbonate, potassium bicarbonate, calcium hydroxide, calcium carbonate, and the like. The potassium and sodium salt forms are particularly preferred.

It should be recognized that the particular counterion forming a part of any salt of this invention is not of a critical nature, so long as the salt as a whole is pharmacologically acceptable and as long as the counterion does not contribute undesired qualities to the salt as a whole.

Typical examples of acyl groups at R_2 in formula I include benzoyl substituted by a polyoxa-alkyl group such as 2-methoxyethoxy (p is 0, m is 1), 2-ethoxyethoxy (p is 0, m is 2), 2-(2-ethoxyethoxy)ethoxy (m is 2, p is 1, n is 2), 3-(2-ethoxyethoxy)propoxy, 4-(2-methoxyethoxy)butoxy, and the like, or benzoyl substituted by alkynyl groups ($-C\equiv C-(C_1-C_{12} \text{ alkyl})$) such as propynyl, butynyl, hexynyl, undecynyl, and the like, or *cis* or *trans* alkenyl groups ($-CH_2=CH_2-(C_1-C_{12} \text{ alkyl})$) such as propenyl, butenyl, hexenyl, decenyl, and the like.

Examples of acyl groups where R_2 is a group of the formula



include diphenyl ethers (Z is $-O-$), diphenyl acetylenes (Z is $-C\equiv C-$), stilbenes (Z is $-CH=CH-$) and biphenyls (Z is a bond).

Examples of diphenyl ether groups include 4-(4-butoxyphenoxy)benzoyl, 4-(4-hexoxyphenoxy)benzoyl, 4-(4-ethoxyphenoxy)benzoyl, 4-(4-phenyloxyphenoxy)benzoyl, 4-[4-(4-dodecyloxyphenoxy)benzoyl, 4-[4-(3-dimethylaminopropoxy)phenoxy]benzoyl and the like.

Examples of diphenyl acetylene and stilbene groups include 4-styrylbenzoyl, 4-(4-methoxystyryl)benzoyl, 4-(4-butoxystyryl)benzoyl, 4-(phenylethynyl)benzoyl, 4-(4-ethoxyphenylethynyl)benzoyl, 4-(4-cyclohexyloxyphenylethynyl)benzoyl and the like.

-12-

Examples of biphenyl groups include 4-[4-(butoxy)phenyl]benzoyl, 4-[4-(cyclobutylmethoxy)phenyl]benzoyl, 4-[4-(cyclopentylmethoxy)phenyl]benzoyl, 4-[4-(cyclohexylethoxy)phenyl]benzoyl, 4-[4-(hexoxy)phenyl]benzoyl, 4-phenylbenzoyl, 4-[4-(11-amino-undecyloxy)phenyl]benzoyl, 4-[4-(11-formamidoundecyloxy)phenyl]benzoyl, 4-[4-(iso-pentoxo)phenyl]benzoyl and the like.

Examples of biphenyl groups where R_4 is $-O-(CH_2)_r-W-R_5$ include 4-[4-[2-(N-cyclohexylpiperidino-4-yl)ethoxy]phenyl]benzoyl, 4-[4-[2-(N-hexylpiperidino-4-yl)ethoxy]phenyl]benzoyl, 4-[4-[2-(4-benzylpiperidino)-ethoxy]phenyl]benzoyl, 4-[4-[2-(4-cyclohexylpiperidino)-ethoxy]phenyl]benzoyl and the like.

Examples of biphenyl and diphenyl ether groups where R_4 is $-Y^1-R_6$ include 4-[4-(phenylethynyl)phenyl]benzoyl, 4-[4-(phenylethynyl)phenoxy]benzoyl, 4-[4-(hexynyl)phenyl]benzoyl, 4-[4-(styryl)phenoxy]benzoyl, 4-[4-[4-(4-methylpiperidino)ethoxy]phenylethynyl]phenyl]benzoyl, and the like.

Acyl groups where R_4 is $-O-(CH_2)_r-W-R_5$ may form acid addition salts of the basic amino groups of the piperidine and piperazine heterocyclic groups with organic or mineral acids such as hydrochloric acid, hydrobromic acid, sulfuric acid and phosphoric acid and with organic acids such as the sulfonic acids, benzenesulfonic acid, toluenesulfonic acid, methanesulfonic acid, acetic acid, chloroacetic acid, trifluoroacetic acid, benzoic acid, isophthalic acid, salicylic acid, citric acid, malic acid, succinic acid, malonic acid and the like.

Table 1, below, provides further examples of acyl groups, R_2 , found on cyclic peptides of formula I.

-13-

Table 1

<u>R₂</u>

5

Table 1 (continued)

<u>R₂</u>

10

-14-

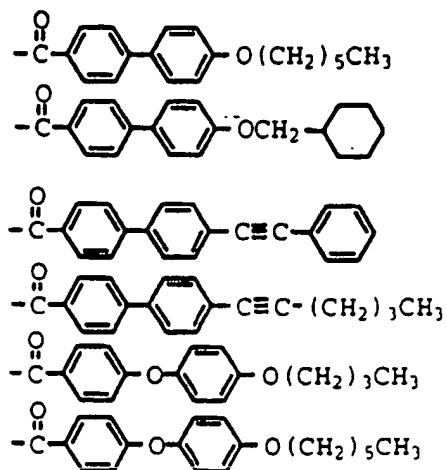
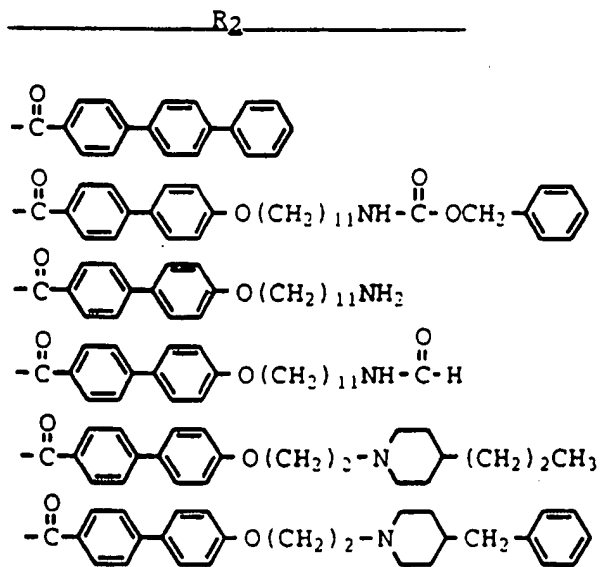
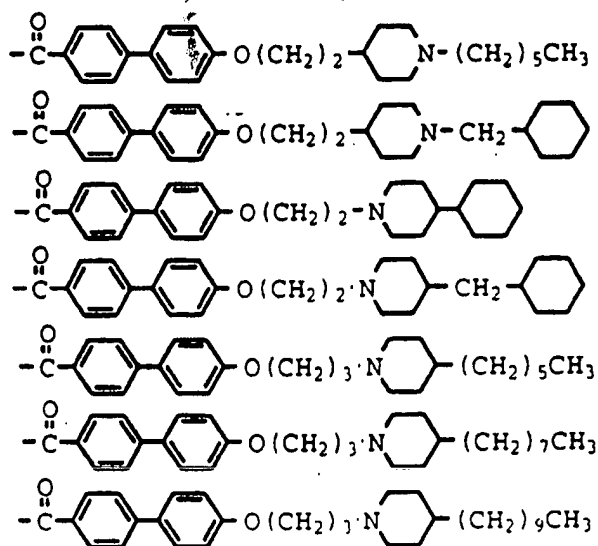


Table 1 (continued)

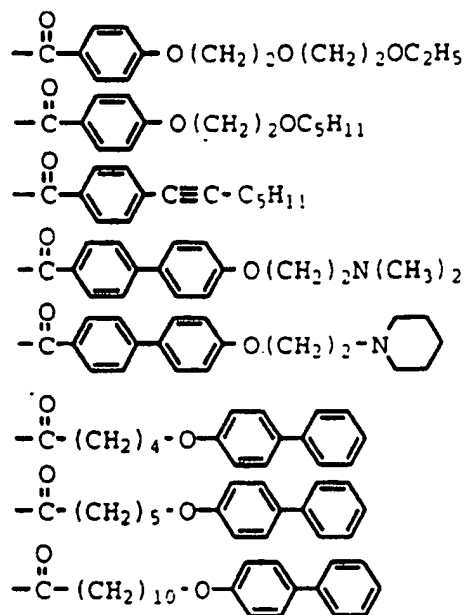
5



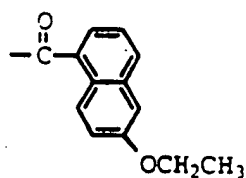
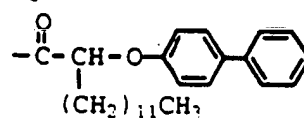
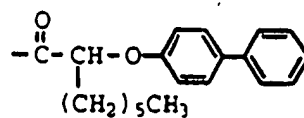
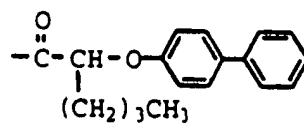
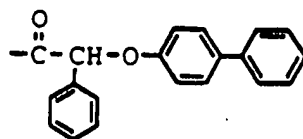
-15-

Table 1 (continued)

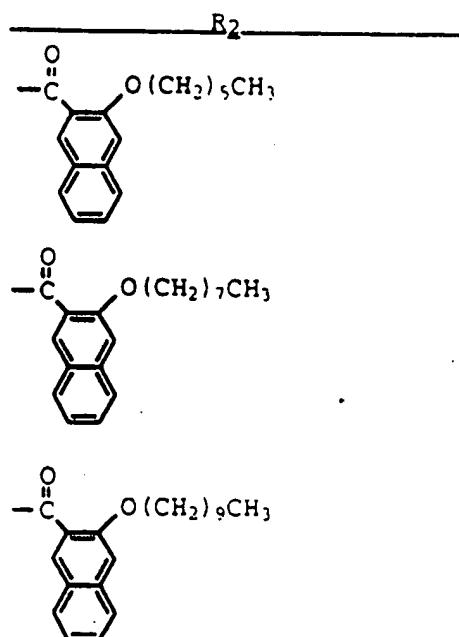
5

R₂

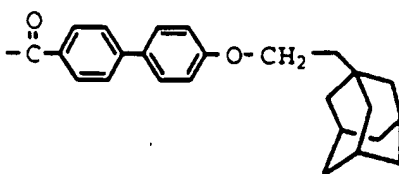
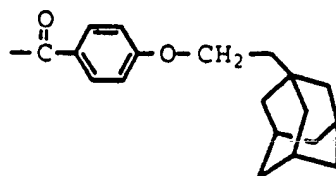
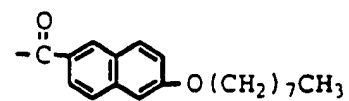
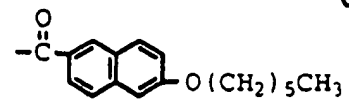
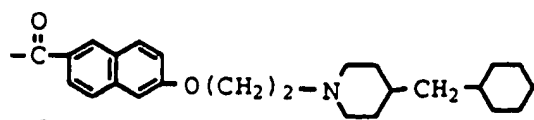
-16-

Table 1 (continued)

5

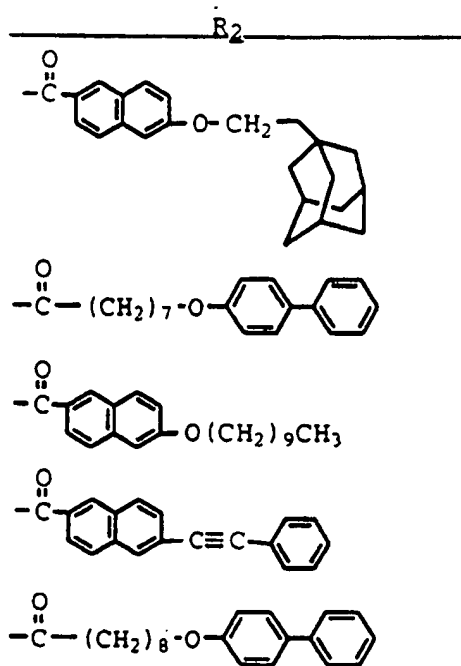


-17-



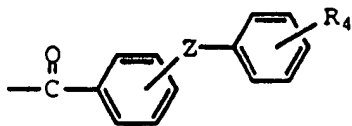
5

Table 1 (continued)



-18-

Preferred acyl groups, R_2 , include groups of the formula:



wherein:

Z is $\text{---C}\equiv\text{C---}$, ---CH=CH--- , $\text{---CH}_2\text{---CH}_2\text{---}$, or a bond;

A) R_4 is hydrogen, $\text{C}_1\text{---C}_{12}$ alkyl, $\text{C}_1\text{---C}_{12}$ substituted alkyl, $\text{C}_2\text{---C}_{12}$ alkenyl, $\text{C}_2\text{---C}_{12}$ substituted alkenyl, $\text{C}_2\text{---C}_{12}$ alkynyl, $\text{C}_2\text{---C}_{12}$ substituted alkynyl, $\text{C}_1\text{---C}_{12}$ alkoxy, $\text{C}_3\text{---C}_{12}$ cycloalkyl, $\text{C}_7\text{---C}_{10}$ bicycloalkyl, $\text{C}_7\text{---C}_{14}$ tricycloalkyl, $\text{C}_3\text{---C}_{12}$ cycloalkoxy, naphthyl, pyridyl, thienyl, benzothienyl, quinolyl or phenyl; or

B) R_4 is phenyl substituted by amino, $\text{C}_1\text{---C}_{12}$ alkylthio, halo, $\text{C}_1\text{---C}_{12}$ alkyl, $\text{C}_2\text{---C}_{12}$ alkenyl, $\text{C}_2\text{---C}_{12}$ alkynyl, $\text{C}_1\text{---C}_{12}$ substituted alkyl, $\text{C}_2\text{---C}_{12}$ substituted alkenyl, $\text{C}_2\text{---C}_{12}$ substituted alkynyl, $\text{C}_1\text{---C}_{12}$ alkoxy, trifluoromethyl, phenyl, substituted phenyl, or a group of the formula $\text{---O---(CH}_2\text{)}_m\text{---[O---(CH}_2\text{)}_n\text{]}_p\text{---O---(C}_1\text{---C}_{12}\text{ alkyl)}$ where m, n and p are as defined above; or

C) R_4 is $\text{C}_1\text{---C}_{12}$ alkoxy substituted with halo, $\text{C}_3\text{---C}_{12}$ cycloalkyl, $\text{C}_7\text{---C}_{10}$ bicycloalkyl, $\text{C}_7\text{---C}_{14}$ tricycloalkyl, $\text{C}_1\text{---C}_6$ alkoxy, $\text{C}_2\text{---C}_{12}$ alkynyl, amino, $\text{C}_1\text{---C}_4$ alkylamino, di($\text{C}_1\text{---C}_4$ alkyl)amino, formamido, $\text{C}_2\text{---C}_{12}$ alkanoylamino, or phenyl substituted with a group of the formula $\text{---O---(CH}_2\text{)}_m\text{---[O---(CH}_2\text{)}_n\text{]}_p\text{---O---(C}_1\text{---C}_{12}\text{ alkyl)}$ where m, n and p are as defined above; or

D) R_4 is $\text{---O---(CH}_2\text{)}_r\text{---W---R}_5$;
 r is 2, 3 or 4;
 W is pyrrolidino, piperidino or piperazino;
 R_5 is hydrogen, $\text{C}_1\text{---C}_{12}$ alkyl, $\text{C}_3\text{---C}_{12}$ cycloalkyl, benzyl or $\text{C}_3\text{---C}_{12}$ cycloalkylmethyl; or

-19-

E) R_4 is $-Y^1-R_6$;

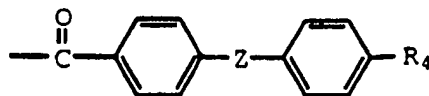
Y^1 is $-C\equiv C-$ or $-CH=CH-$;

R_6 is C_3-C_{12} cycloalkyl, C_7-C_{10} bicycloalkyl,
 5 C_7-C_{14} tricycloalkyl, C_3-C_{12} cycloalkenyl, naphthyl,
 benzothiazolyl, thienyl, indanyl, fluorenyl, or phenyl
 substituted with C_1-C_{12} alkylthio, C_2-C_{12} alkenyl, C_2-C_{12}
 alkynyl, halo(C_1-C_6 alkoxy) or a group of the formula
 $-O-(CH_2)_r-W-R_5$ where r , W and R_5 are as defined above; or
 10 R_6 is phenyl substituted with a group of the
 formula $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$ where m , n
 and p are as defined above; or

F) R_4 is C_1-C_{12} alkoxy substituted with a group of
 15 the formula $-NHC(O)R_7$;

R_7 is C_1-C_6 alkoxy, or phenyl(C_1-C_6 alkoxy);
 or a pharmaceutically acceptable salt thereof.

More preferred are acyl groups, R_2 , of the formula:
 20



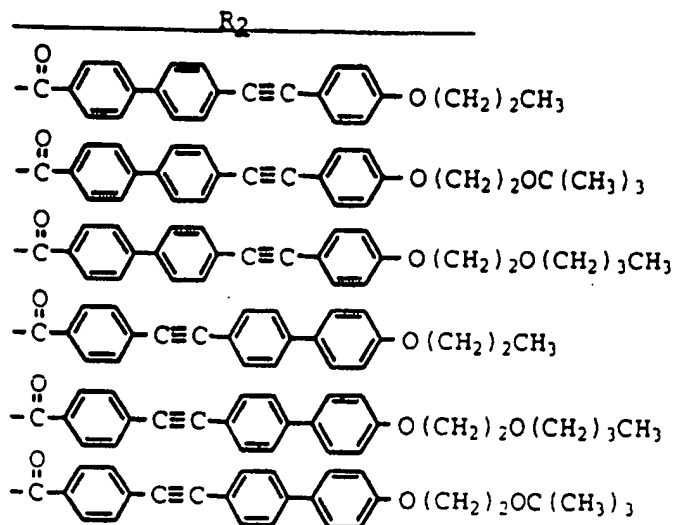
where Z is $-C\equiv C-$ or a bond;

or a pharmaceutically acceptable salt thereof.

25 Table 2, below, provides a list of preferred
 acyl groups, R_2 , found on cyclic peptides of formula I.

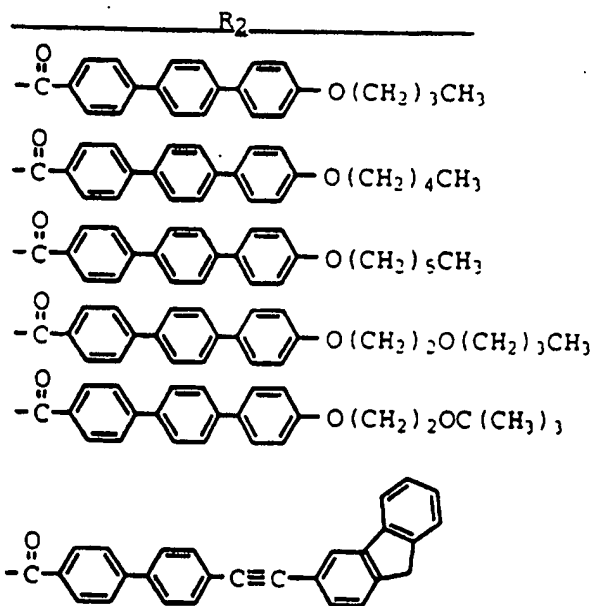
-20-

Table 2



5

Table 2 (continued)



10

Preferred compounds of this invention are those compounds of formula I where:

R', R'', and R''' are each methyl;

RY¹, RY², RY³, RY⁴ are each hydroxy;

15

-21-

or a pharmaceutically acceptable salt thereof.

Of these compounds, more preferred are those compounds of formula I where:

5

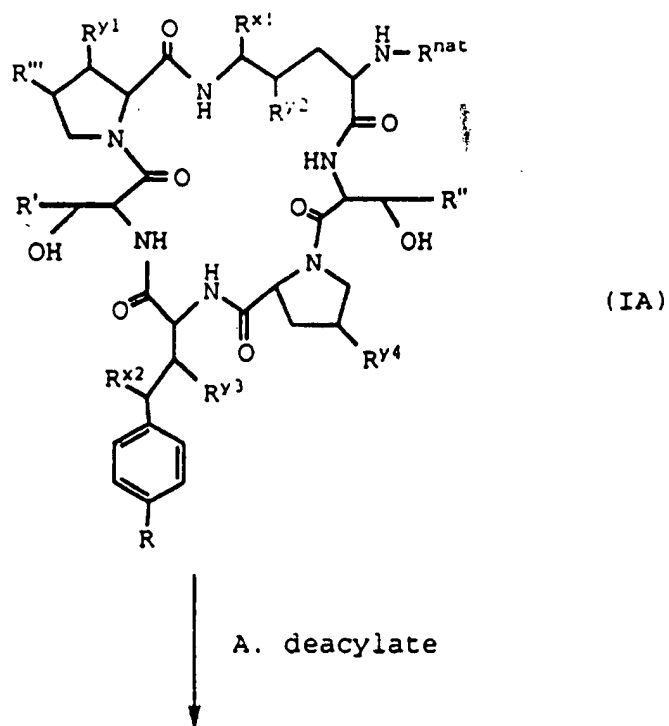
R^{x1} and R^{x2} are hydrogen;

or a pharmaceutically acceptable salt thereof.

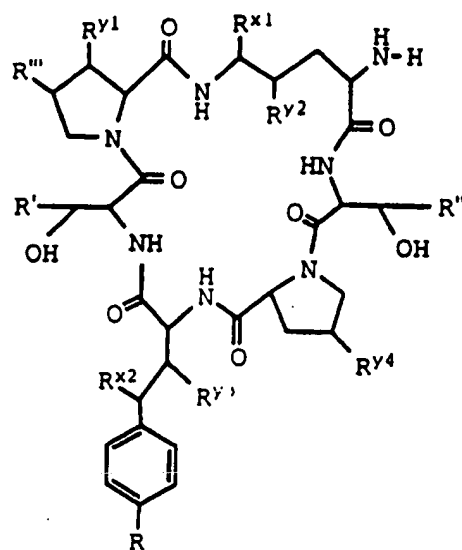
The compounds of formula I may be prepared according to Reaction Scheme I, as follows.

10

Reaction Scheme I

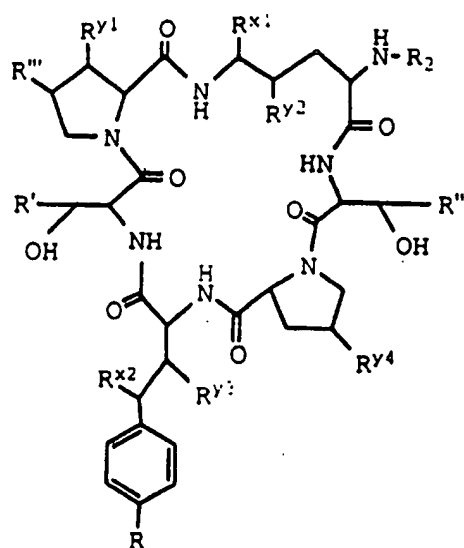


-22-



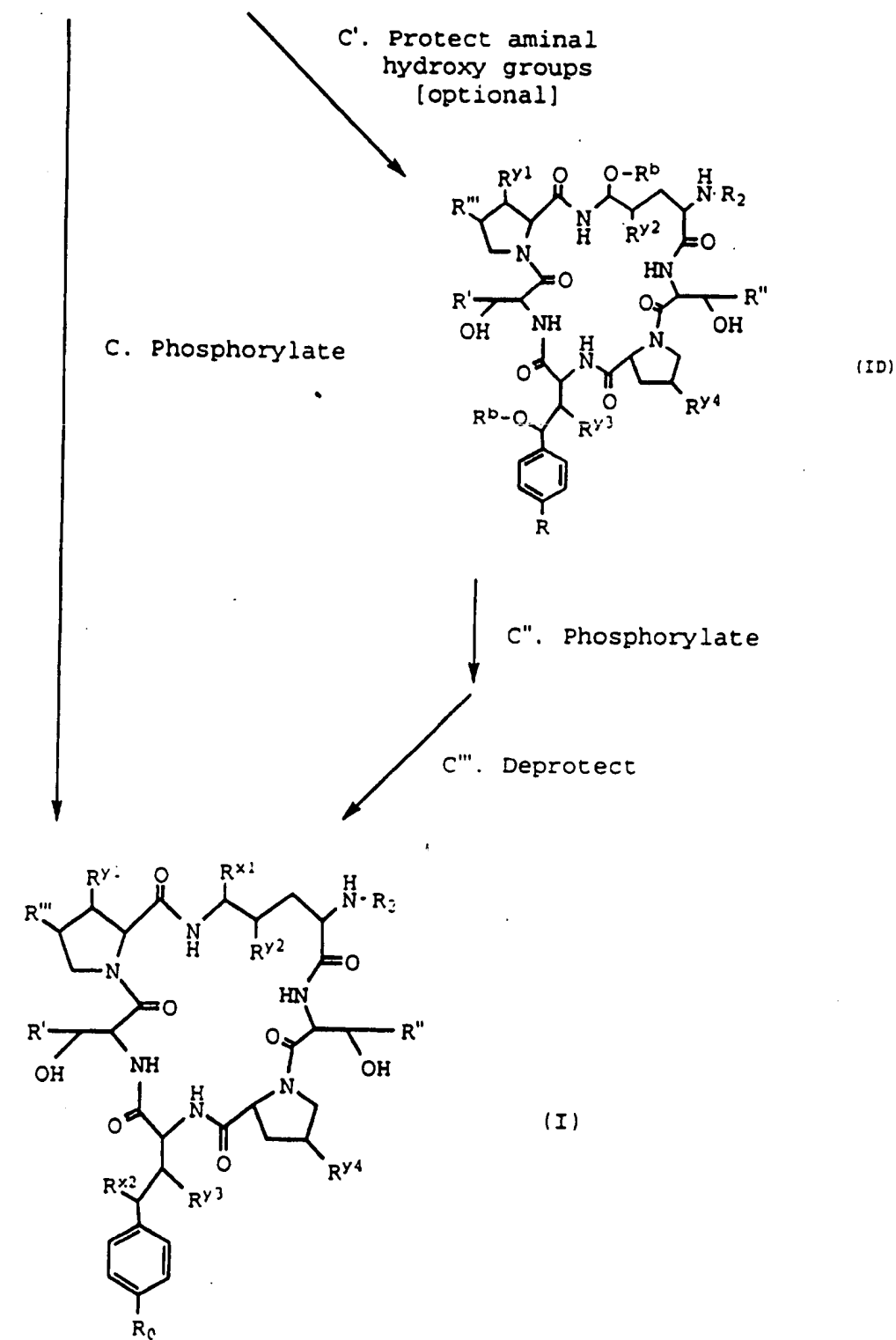
(IB)

B. re-acylate



(IC)

-23-



-24-

R^{nat} is a naturally occurring cyclic peptide sidechain;

R is hydroxy;

R^b is an hydroxy protecting group; and

5 R', R'', R''', R^{x1}, R^{x2}, RY¹, RY², RY³, RY⁴, R, R₀ and R₂ are as defined above.

Reaction scheme I, above, is accomplished by carrying out reactions A-C (or A-C'''), in order. Once a reaction is complete, the intermediate compound may be
10 isolated by procedures well-known in the art, for example, the compound may be crystallized and then collected by filtration, or the reaction solvent may be removed by extraction, evaporation or decantation. The intermediate compound may be further purified, if desired, by common
15 techniques such as crystallization or chromatography over solid supports such as silica gel, alumina and the like, before carrying out the next step of the reaction scheme.

In reaction IA, a naturally occurring cyclic peptide of the formula (IA) is deacylated using procedures
20 known in the art to provide an amino nucleus of formula (IB). This reaction is typically carried out using enzymatic acylation by exposing the naturally occurring cyclic peptide to a deacylase enzyme. The deacylase enzyme may be obtained from the microorganism Actinoplanes
25 utahensis and used substantially as described in U.S. Patent Nos. 4,293,482 and 4,304,716, herein incorporated by reference. The deacylase enzyme may also be obtained from the Pseudomonas species. Deacylation may be accomplished using whole cells of Actinoplanes utahensis
30 or Pseudomonas or the crude or purified enzyme thereof or using an immobilized form of the enzyme. See European Patent Application No. 0 460 882 (December 11, 1991). Examples of naturally occurring cyclic peptides which may be used as starting materials include aculeacin (palmitoyl
35 side chain), tetrahydroechinocandin B (stearoyl side chain), mulundocandin (branched C₁₅ side chain), L-671,329 (C₁₆ branched side chain), S 31794/F1 (tetradecanoyl side

-25-

chain), sporiofungin (C_{15} branched side chain), FR901379 (palmitoyl side chain) and the like. A preferred naturally occurring cyclic peptide is echinocandin B (a compound of formula (IA) where R' , R'' , and R''' are each methyl, R^{x1} and R^{x2} are each hydroxy, RY^1 , RY^2 , RY^3 , RY^4 are each hydroxy, R is hydroxy and R_2 is linoleoyl).

In Reaction IB, the resulting amino nucleus is then re-acylated using procedures known in the art to provide a compound of formula I where R_2 is an acyl group as defined hereinabove.

For example, the amino nucleus may be acylated by reaction with an appropriately substituted acyl halide, preferably in the presence of an acid scavenger such as a tertiary amine, such as triethylamine. The reaction is typically carried out at a temperature of from about -20°C to about 25°C . Typical solvents for this reaction include polar aprotic solvents such as dioxane or dimethylformamide. Solvent choice is not critical so long as the solvent employed is inert to the ongoing reaction and the reactants are sufficiently solubilized to effect the desired reaction.

The amino nucleus may also be acylated by reaction with an appropriately substituted carboxylic acid, in the presence of a coupling agent. Typical coupling agents include dicyclohexylcarbodiimide (DCC), N,N' -carbonyldiimidazole, bis(2-oxo-3-oxazolidinyl)phosphinic chloride (BOP-Cl), N -ethoxycarbonyl-2-ethoxy-1,2-dihydroquinoline (EEDQ), benzotriazol-1-yloxytripyrrolidinophosphonium hexafluorophosphate (PyBOP) and the like.

In addition, the amino nucleus may be acylated with an activated ester of a carboxylic acid (RCOOH) such as an ester of a carboxylic acid of the formula $R_2\text{-COOH}$ and p -nitrophenyl, 2,4,5-trichlorophenyl, hydroxybenzotriazole hydrate (HOBT $\cdot\text{H}_2\text{O}$), pentafluorophenol, N -hydroxysuccinimide and the like. Preferred acylating moieties are the active esters of the carboxylic acid $R_2\text{-COOH}$ such as 2,4,5-

-26-

trichlorophenyl ester and HOBT ester. The reaction is typically carried out for one to sixty five hours at a temperature from about 0°C to about 30°C in an aprotic solvent. The reaction is generally complete after about
5 twenty four to forty eight hours when carried out a temperature of from about 15°C to about 30°C. Typical solvents for this reaction are tetrahydrofuran and dimethylformamide or a mixture of such solvents. The amino nucleus is generally employed in equimolar proportions
10 relative to the activated ester or with a slight excess of the amino nucleus.

In Reaction IC, the compound of formula (IC) is phosphorylated by reaction with an appropriately substituted alkyl or phenyl phosphate to provide a compound
15 of formula I where R_0 is $P(O)_2OH-R_1$ where R_1 is C_1-C_6 alkoxy or phenoxy, or by reaction with an appropriately substituted alkyl or phenyl phosphonic acid to provide a compound of formula I where R_0 is $-P(O)_2OH-R_1$ where R_1 is C_1-C_6 alkyl, an appropriately substituted phenyl or benzyl
20 moiety. The reaction is carried out in the presence of a base such as lithium trimethyl-silanolate (LiOTMS), lithium bis(trimethylsilyl)amide (LHMDS), pyridine and the like. The reaction is typically carried out for up to one hour at a temperature from about -30°C to about 0°C in an aprotic
25 solvent such as tetrahydrofuran and dimethylformamide. The reaction is generally complete in about fifteen minutes when carried out under these conditions. The phosphate or phosphonate reactant is generally employed in equimolar proportions to about a one mole excess relative to the
30 amino nucleus in the presence of an equimolar or slight excess of the base. Phosphorylation of an amino nucleus with unprotected amination hydroxy groups (R^{x1} and R^{x2}) is typically carried out at a temperature from about -30°C to about -15°C.

35 Alternatively, in Reaction IC' the acylated nucleus of formula (IC), where R^{x1} and/or R^{x2} are hydroxy, may be optionally protected with an hydroxy protecting

group using procedures known in the art. For example, the reaction is typically carried out by combining the compound of formula (IC) with a suitable hydroxy protecting group in the presence of a catalyst at a temperature in the range of from about 0°C to about 40°C for about one to five hours in a mutual inert solvent. The hydroxy protecting group is generally employed in an amount ranging from about equimolar proportions to about a 100 molar excess relative to the compound of formula (IC), preferably in a large molar excess. Suitable catalysts include strong acids such as p-toluenesulfonic acid, camphorsulfonic acid (CSA), hydrochloric acid, sulfuric acid, trifluoroacetic acid and the like. Typical solvents suitable for use in this reaction include any organic solvent such as dioxane. Solvent choice is not critical so long as the solvent employed is inert to the ongoing reaction and the reactants are sufficiently solubilized to effect the desired reaction. The reaction is preferably conducted at a temperature in the range of from about 20°C to about 30°C for about 2 to 4 hours. It is not necessary to protect the dideoxy compounds of formula (IC), that is, those compounds of formula (IC) where R^{x1} and R^{x2} are hydrogen.

Reaction IC" is carried out as described above in Reaction IC, above.

In Reaction IC"', the hydroxy protecting groups that were used to protect the aminor hydroxy moieties in Reaction IC', above, are removed according to procedures known in the art to provide the desired compound of formula I. For example, the protecting groups can be removed by reaction with a Lewis acid in a mutual inert organic solvent such as methylene chloride. Examples of Lewis acids include trimethylsilylbromide, boron trifluoride etherate and the like. The reaction is typically carried out at a temperature of from about 0°C to about 40°C, preferably at a temperature of from about 20°C to about 30°C. A preferred Lewis acid is boron trifluoride etherate.

-28-

The cyclic peptides used to make the compounds of the present invention may be prepared by fermentation of known microorganisms. For example, the cyclic peptide of formula (IB) where R', R'', and R''' are methyl, R^{x1} and R^{x2} are hydroxy, RY¹, RY², RY³, RY⁴ are hydroxy, and R is hydroxy (cyclic nucleus corresponding to A-30912A) may be prepared using the procedure detailed in Abbott et al., U.S. Pat. Ser. No. 4,293,482, which is herein incorporated by reference. The cyclic peptide of formula (IB) where R', R'', and R''' are methyl, R^{x1} is hydroxy, R^{x2} is hydrogen, RY¹, RY², RY³, RY⁴ are hydroxy and R is hydroxy (cyclic nucleus corresponding to A-30912B) may be prepared using the procedure detailed in Abbott et al., U.S. Pat. Ser. No. 4,299,763, which is herein incorporated by reference. The cyclic peptide of formula (IB) where R', R'', and R''' are methyl, R^{x1} and R^{x2} are hydrogen, RY¹, RY³ and RY⁴ are hydroxy, RY² is hydrogen and R is hydroxy (cyclic nucleus corresponding to A-30912D) may be prepared using the procedure detailed in Abbott et al., U.S. Pat. Ser. No. 4,299,762, which is herein incorporated by reference. Aculeacin may be prepared using the procedure detailed in Mizuno et al., U.S. Pat. Ser. No. 3,978,210 which is herein incorporated by reference. The cyclic peptide of formula (IB) where R' is -CH₂C(O)NH₂, R'' is methyl, R''' is hydrogen, R^{x1}, R^{x2}, RY¹, RY³, RY⁴ are hydroxy, R is hydroxy may be prepared by deacylating the cyclic peptide prepared using the procedure detailed in Shieh-Shung et al., U.S. Pat. Ser. No. 5,198,421, which is herein incorporated by reference.

The dideoxy compounds of formula I are prepared by removing the benzylic and aminor hydroxy groups (R^{x2} and R^{x1}, respectively). The hydroxy groups may be removed by subjecting a non-dideoxy compound of formula I (where R₂ is hydrogen or acyl) to a strong acid and a reducing agent at a temperature of between -5°C and 70°C, in a suitable solvent. Typical strong acids include trichloroacetic acid, trifluoroacetic acid or borontrifluoride etherate. A

-29-

preferred strong acid is trifluoroacetic acid. Typical reducing agents include sodium cyanoborohydride or triethylsilane. A preferred reducing agent is triethylsilane. Suitable solvents include methylene chloride, chloroform or acetic acid, preferably methylene chloride. The strong acid should be present in an amount of from 2 to 60 mol per mol of substrate, and the reducing agent should be present in an amount of 2 to 60 mol per mol of substrate. This process affords selective removal of the amination and benzylic hydroxy groups.

The R_2 -COOH precursor acids are prepared by hydrolyzing a nitrile of the formula R_2 -CN or an ester of the formula R_2 -COO(C_1 - C_4 alkyl). The nitrile and ester intermediates may be prepared using procedures known in the art.

For example, the nitrile and ester intermediates where R_2 is an alkoxy aryl moiety may be prepared using Procedure A or Procedure B, described below.

20

Procedure A

One equivalent of an alkyl bromide, iodide, or p-toluenesulfonate is added to a mixture containing one equivalent of a base, such as potassium t-butoxide or potassium carbonate, and one equivalent of an hydroxy aryl compound in 200-300 ml of acetonitrile. The resulting reaction mixture is refluxed for approximately six hours and then concentrated in vacuo to provide a residue. This residue is dissolved in a mixture of diethyl ether and a 2N sodium hydroxide solution. The resulting layers are separated and the organic layer is dried over magnesium sulfate, filtered and dried to provide the desired alkoxy aryl product.

30

Procedure B

35

One equivalent of diethylazodicarboxylate is added dropwise over ten minutes, at room temperature, to a mixture containing one equivalent of an hydroxy aryl

-30-

compound, one equivalent of an alkyl alcohol and one equivalent of triphenylphosphine in 200-300 ml of tetrahydrofuran. After approximately seventeen hours, the solvent is removed in vacuo to provide a residue. This residue is dissolved in diethyl ether and the resulting mixture is washed with a 2N sodium hydroxide solution, dried over magnesium sulfate, filtered and concentrated to provide a product which is then crystallized from a diethyl ether/pentane mixture or, if the product contains a tertiary amine, the hydrochloride salt is formed and crystallized from a methanol/ethyl acetate mixture.

The nitrile and ester intermediates where R_2 is an alkynyl or alkenyl aryl moiety may be prepared using Procedure C, below.

Procedure C

A mixture containing two equivalents of triethylamine, 0.05 equivalent of palladium dichloride, 0.1 equivalent of triphenylphosphine, 0.025 equivalent of cuprous iodide and one equivalent of an alkyne or two equivalents of an alkene, is added to one equivalent of an aryl bromide, iodide, or trifluoromethanesulfonate in acetonitrile (600 ml/0.1 mol of aryl reactant), under nitrogen. The resulting mixture is refluxed for approximately seventeen hours and then the solvent is removed in vacuo to provide a residue. This residue is slurried in 300 ml of diethyl ether and then filtered to remove the resultant solids. The filtrate is washed with a 1N hydrochloric acid solution, dried over magnesium sulfate, filtered and then dried to provide the desired product.

The ester intermediates where R_2 is a terphenyl moiety may be prepared using Procedure D, below.

-31-

Procedure D1. Formation of boronic acid reactant

Butyl lithium (1.2 equivalents) is added to one equivalent of a cold (-78°C) aryl halide in tetrahydrofuran. After approximately fifteen minutes, two equivalents of triisopropyl borate are added. After approximately ten minutes, the reaction mixture is warmed to room temperature, and then quenched by the addition of water, followed by the addition of a 1N hydrochloric acid solution. The resulting layers are separated and the organic layer is concentrated *in vacuo* to provide a solid. This solid is collected by filtration and then washed with hexane to provide a pure boronic acid product.

2. Formation of terphenyl ester

Tetrakis(triphenylphosphine)palladium (0.03 equivalent) is added to a mixture containing one equivalent of an aryl boronic acid, 1.5 equivalents of potassium carbonate and one equivalent of methyl 4-iodobenzoate (or trichlorophenyl ester of iodobenzoate) in nitrogen-purged toluene. The resulting reaction mixture is refluxed for approximately seven hours and then decanted to remove the potassium carbonate and dried *in vacuo* to provide a residue. This residue is triturated in acetonitrile and then filtered to provide the desired solid product.

The aryl nitriles and esters described above may be converted to the corresponding carboxylic acids by hydrolysis using Procedure E or Procedure F, below.

Procedure E

An aryl nitrile is dissolved in ethanol and an excess of 50% sodium hydroxide solution and refluxed for approximately two hours. Water is added to the resulting reaction mixture until a solid precipitates. This solid is collected by filtration, added to a dioxane/6N hydrochloric

-32-

acid mixtur and the resulting mixture is refluxed for approximately seventeen hours. When the reaction is substantially complete, the carboxylic acid product is crystallized by the addition of water and then collected by filtration and dried *in vacuo*.

Procedure F

An excess of a 2N sodium hydroxide solution is added to an aryl ester in methanol, and the resulting solution is refluxed for approximately five hours and then acidified by the addition of excess hydrochloric acid. Water is added to the resulting reaction mixture until a solid (carboxylic acid) precipitates. The carboxylic acid is collected by filtration and dried *in vacuo*.

The carboxylic acids may be converted to the corresponding 2,4,5-trichlorophenyl esters using Procedure G, below. These activated esters are then used to acylate the amino nucleus, as described above in Reaction Scheme IC.

Procedure G

A mixture containing one equivalent of an aryl carboxylic acid, one equivalent of 2,4,5-trichlorophenol, and one equivalent of N,N'-dicyclohexylcarbodiimide (DCC) in methylene chloride is stirred for approximately seventeen hours and then filtered. The filtrate is concentrated to provide a residue. This residue is dissolved in diethyl ether, filtered, and pentane is added until crystallization begins. The crystalline product is collected by filtration and dried *in vacuo*.

The following Preparations and Examples further describe how to synthesize the compounds of the present invention. The terms melting point, proton nuclear magnetic resonance spectra, mass spectra, infrared spectra, ultraviolet spectra, elemental analysis, high performance

-33-

liquid chromatography, and thin layer chromatography are abbreviated "m.p.", "NMR", "MS", "IR", "UV", "Analysis", "HPLC", and "TLC", respectively. In addition, the absorption maxima listed for the IR spectra are only those of interest and not all of the maxima observed.

In conjunction with the NMR spectra, the following abbreviations are used: "s" is singlet, "d" is doublet, "dd" is doublet of doublets, "t" is triplet, "q" is quartet, "m" is multiplet, "dm" is a doublet of multiplets and "br.s", "br.d", "br.t", and "br.m" are broad singlet, doublet, triplet, and multiplet respectively. "J" indicates the coupling constant in Hertz (Hz). Unless otherwise noted, NMR data refers to the free base of the subject compound.

The nuclear magnetic resonance spectra were obtained on a General Electric QE-300 300 MHz instrument. The chemical shifts are expressed in delta (δ) values (parts per million downfield from tetramethylsilane).

Preparation 1

The following nitrile and ester intermediates where R₂ is an alkoxy aryl moiety were prepared substantially in accordance with Procedure A, detailed above.

Table A











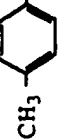

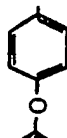






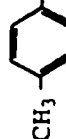
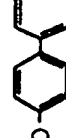









Alkyl halide or tosylate	mass (g)	Alkoxy aryl product	mass (g)
I-(CH ₂) ₃ CH ₃	9.4	CH ₃ (CH ₂) ₃ O-C ₆ H ₄ -CN	3.2
CH ₃ -C ₆ H ₄ -SO ₃ -CH ₂ - 	12.3	 -CH ₂ O-C ₆ H ₄ -CN	5.3
Br-(CH ₂) ₂ CH(CH ₃) ₂	7.7	(CH ₃) ₂ CH(CH ₂) ₂ O-C ₆ H ₄ -CN	9.2
CH ₃ -C ₆ H ₄ -SO ₃ -(CH ₂) ₂ O(CH ₂) ₄ CH ₃	7.6	CH ₃ (CH ₂) ₄ O-(CH ₂) ₂ O-C ₆ H ₄ -CN	4.8
Br-(CH ₂) ₄ CH ₃	15.3	CH ₃ (CH ₂) ₄ O-C ₆ H ₄ -CN	20.3
CH ₃ -C ₆ H ₄ -SO ₃ -CH ₂ - 	13.0	 -CH ₂ O-C ₆ H ₄ -CN	12.2
CH ₃ -C ₆ H ₄ -SO ₃ -(CH ₂) ₂ C(CH ₃) ₃	13.1	(CH ₃) ₃ C(CH ₂) ₂ O-C ₆ H ₄ -CN	11.8
Br-CH ₂ CH(CH ₂ CH ₃) ₂	8.5	(CH ₂ CH ₃) ₂ CHCH ₂ O-C ₆ H ₄ -CN	3.0
I-(CH ₂) ₅ CH ₃	10.8	CH ₃ (CH ₂) ₅ O-C ₆ H ₄ -CN	11.4
Br-(CH ₂) ₂ - 	4.2	 -(CH ₂) ₂ O-C ₆ H ₄ -CO ₂ CH ₃	4.5

Table A (continued)

<u>Alkyl halide or tosylate</u>	<u>mass</u> (g)	<u>Alkoxy aryl product</u>	<u>mass</u> (g)
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{O(CH}_2)_6\text{CH}_3$	23.4	$\text{CH}_3\text{(CH}_2)_6\text{O-(CH}_2)_2\text{O-}$  $\text{CO}_2\text{CH}_2\text{CH}_3$	20.9
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{O(CH}_2)_7\text{CH}_3$	25.8	$\text{CH}_3\text{(CH}_2)_7\text{O-(CH}_2)_2\text{O-}$  $\text{CO}_2\text{CH}_2\text{CH}_3$	7.9
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{O(CH}_2)_9\text{CH}_3$	27.1	$\text{CH}_3\text{(CH}_2)_9\text{O-(CH}_2)_2\text{O-}$  $\text{CO}_2\text{CH}_2\text{CH}_3$	21.0
$\text{I-(CH}_2)_3\text{CH}_3$	6.1	$\text{CH}_3\text{(CH}_2)_3\text{O-}$  CO_2CH_3	12.3
$\text{I-(CH}_2)_5\text{CH}_3$	4.3	$\text{CH}_3\text{(CH}_2)_5\text{O-}$  CO_2CH_3	4.7
$\text{I-(CH}_2)_2\text{CH}_3$	2.6	$\text{CH}_3\text{(CH}_2)_2\text{O-}$  $\text{C}\equiv\text{C-}$  CO_2CH_3	4.4
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{O(CH}_2)_3\text{CH}_3$	2.7	$\text{CH}_3\text{(CH}_2)_3\text{O-(CH}_2)_2\text{O-}$  $\text{C}\equiv\text{C-}$  CO_2CH_3	2.6
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{OC(CH}_3)_3$	2.7	$\text{(CH}_3)_3\text{CO-(CH}_2)_2\text{O-}$  $\text{C}\equiv\text{C-}$  CO_2CH_3	2.6
$\text{I-(CH}_2)_2\text{CH}_3$	3.8	$\text{CH}_3\text{(CH}_2)_2\text{O-}$  $\text{C}\equiv\text{C-}$  CO_2CH_3	1.4
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{O(CH}_2)_3\text{CH}_3$	3.6	$\text{CH}_3\text{(CH}_2)_3\text{O-(CH}_2)_2\text{O-}$  $\text{C}\equiv\text{C-}$  CO_2CH_3	5.1
 $\text{CH}_3\text{SO}_3\text{-(CH}_2)_2\text{OC(CH}_3)_3$	4.9	$\text{(CH}_3)_3\text{CO-(CH}_2)_2\text{O-}$  $\text{C}\equiv\text{C-}$  CO_2CH_3	5.2

-36-

Preparation 2

The following nitrile and ester intermediates where R₂ is an alkoxy aryl moiety were prepared substantially in accordance with Procedure B, detailed

5
above.

-37-

Table B

Alkyl alcohol	mass (g)	Alkoxy Aryl Product	mass (g)
$\text{HO}-(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2\text{CH}_3$	3.6	$\text{CH}_3(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	6.2
$\text{HO}-(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2\text{CH}_2-\text{C}_6\text{H}_5$	6.1	$\text{C}_6\text{H}_5-\text{CH}_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	4.3
$\text{HO}-(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_5\text{CH}_3$	0.5	$\text{CH}_3(\text{CH}_2)_5-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	0.8
$\text{HO}-(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2-\text{C}_6\text{H}_{10}$	0.5	$\text{C}_6\text{H}_{10}-\text{CH}_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	0.5
$\text{HO}-(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2-\text{C}_6\text{H}_{10}-\text{C}_6\text{H}_{10}$	2.3	$\text{C}_6\text{H}_{10}-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	1.3
$\text{HO}-(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2-\text{C}_6\text{H}_{10}-\text{CH}_2-\text{C}_6\text{H}_{10}$	9.3	$\text{C}_6\text{H}_{10}-\text{CH}_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	9.6
$\text{HO}-\text{CH}_2-\text{C}_6\text{H}_4-(\text{CH}_2)_3\text{CH}_3$	10.0	$\text{CH}_3(\text{CH}_2)_3-\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_2\text{CH}_3$	13.6








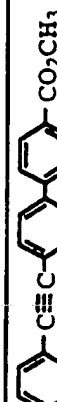


SUBSTITUTE SHEET (RULE 26)

-38-

Preparation 3

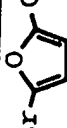


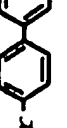

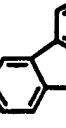

The following ester intermediates where R₂ is an alkynyl or alkenyl aryl moiety were prepared substantially in accordance with Procedure C, detailed above.

Table C

Alkene or alkyne	mass (g)	Aryl halide	mass (g)	Alkenyl or alkynyl aryl product	mass (g)
$\text{HC}\equiv\text{C}-(\text{CH}_2)_5\text{CH}_3$	12.1		28.8	$\text{CH}_3(\text{CH}_2)_5-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	26.2
$\text{HC}\equiv\text{C}-(\text{CH}_2)_5\text{CH}_3$	6.1		14.4	$\text{CH}_3(\text{CH}_2)_5-\text{CH}=\text{CH}^{(\text{trans})}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	0.6
$\text{HC}\equiv\text{C}-(\text{CH}_2)_7\text{CH}_3$	15.2		28.8	$\text{CH}_3(\text{CH}_2)_7-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	28.1
$\text{HC}\equiv\text{C}-\text{C}_6\text{H}_5$	1.9		5.1		1.9
$\text{HC}\equiv\text{C}-\text{Si}(\text{CH}_3)_3$	4.3		11.5	$(\text{CH}_3)_3\text{Si}-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	11.2
$\text{HC}\equiv\text{C}-\text{C}_6\text{H}_5$	1.8		6.0		2.6
$\text{HC}\equiv\text{C}-(\text{CH}_2)_3\text{CH}_3$	1.4		6.0	$\text{CH}_3(\text{CH}_2)_3-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	5.1
$\text{HC}\equiv\text{C}-\text{Si}(\text{CH}_3)_3$	10.9		40.0	$(\text{CH}_3)_3\text{Si}-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	23.3

-39-

Table C (continued)

Alkene or alkyne	mass (g)	Aryl halide	mass (g)	Alkenyl or alkynyl aryl product	mass (g)
$\text{HC}\equiv\text{C}-(\text{CH}_2)_7\text{CH}_3$	7.6		11.3	$\text{CH}_3(\text{CH}_2)_7-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{O}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	11.4
$\text{HC}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	10.5		9.7		10.2
$\text{HC}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	22.2		34.4		19.4
$\text{HC}\equiv\text{C}-\text{C}_6\text{H}_4-\text{CO}_2\text{CH}_3$	1.2		1.2		1.5

-40-

-41-

Preparation 4

The following ester intermediates where R₂ is a terphenyl moiety were prepared substantially in accordance with Procedure D, detailed above.

5

Table D.1







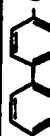

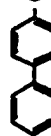

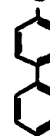

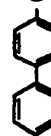


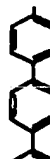
<u>Aryl halide</u> (R ^D is bromide)	<u>mass</u> (g)	<u>Boronic acid</u> <u>reactant</u> (R ^D is B(OH) ₂ mass (g))
R ^D -  -O(CH ₂) ₃ CH ₃	10.6	6.1
R ^D -  -O(CH ₂) ₄ CH ₃	31.0	12.0
R ^D -  -O(CH ₂) ₅ CH ₃	10.9	4.1
R ^D -  -O(CH ₂) ₂ -O(CH ₂) ₃ CH ₃	13.6	5.7
R ^D -  -O(CH ₂) ₂ -OC(CH ₃) ₃	5.0	1.9

Table D.2

Boronic acid reactant	mass (g)	CH_3CO_2 - 	mass (g)	Product	mass (g)
$(\text{HO})_2\text{B}$ -  - $\text{O}(\text{CH}_2)_3\text{CH}_3$	5.0	3.2		CH_3CO_2 -  - $\text{O}(\text{CH}_2)_3\text{CH}_3$	4.2
$(\text{HO})_2\text{B}$ -  - $\text{O}(\text{CH}_2)_4\text{CH}_3$	6.0	3.7		CH_3CO_2 -  - $\text{O}(\text{CH}_2)_4\text{CH}_3$	5.2
$(\text{HO})_2\text{B}$ -  - $\text{O}(\text{CH}_2)_5\text{CH}_3$	3.4	2.8		CH_3CO_2 -  - $\text{O}(\text{CH}_2)_5\text{CH}_3$	3.5
$(\text{HO})_2\text{B}$ -  - $\text{O}(\text{CH}_2)_2 - \text{O}(\text{CH}_2)_3\text{CH}_3$	3.7	3.6		CH_3CO_2 -  - $\text{O}(\text{CH}_2)_2 - \text{O}(\text{CH}_2)_3\text{CH}_3$	3.7
$(\text{HO})_2\text{B}$ -  - $\text{O}(\text{CH}_2)_2 - \text{OC}(\text{CH}_3)_3$	1.8	1.5		CH_3CO_2 -  - $\text{O}(\text{CH}_2)_2 - \text{OC}(\text{CH}_3)_3$	2.2

-43-

Preparation 5

5 The following activated esters were prepared
substantially in accordance with Procedure G, detailed
above.

Table G

Carboxylic acid	mass (g)	mass (g) activated ester (2,4,5-trichlorophenyl ester)
$\text{CH}_3(\text{CH}_2)_3\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	1.9	1.8
$\text{Cyclopentyl}-\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	4.2	4.4
$(\text{CH}_3)_2\text{CH}(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	3.0	1.7
$\text{CH}_3(\text{CH}_2)_4\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	2.2	1.3
$\text{CH}_3(\text{CH}_2)_4\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	5.7	5.1
$\text{Cyclopentyl}-\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	4.4	3.1
$(\text{CH}_3)_3\text{C}(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	2.3	2.6
$(\text{CH}_3\text{CH}_2)_2\text{CHCH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	1.5	0.8
$\text{CH}_3(\text{CH}_2)_5\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	5.3	4.8
$\text{Cyclohexyl}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	3.1	1.0
$\text{CH}_3(\text{CH}_2)_6\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	5.6	2.9
$\text{CH}_3(\text{CH}_2)_7\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	7.8	6.6

Table G (continued)

Carboxylic acid	mass (g)	mass (g) (2,4,5-trichlorophenyl ester)	mass (g) activated ester
$\text{CH}_3(\text{CH}_2)_9\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	6.4		1.3
$\text{CH}_3(\text{CH}_2)_3-\text{C}_6\text{H}_4-\text{CH}_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	4.0		3.2
$\text{CH}_3(\text{CH}_2)_3\text{O}-\text{C}_6\text{H}_4-\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	5.8		1.4
$\text{CH}_3(\text{CH}_2)_5\text{O}-\text{C}_6\text{H}_4-\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	3.8		2.4
$\text{CH}_3(\text{CH}_2)_3\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	2.9		2.5
$\text{CH}_3(\text{CH}_2)_3\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	2.0		1.5
$(\text{CH}_3)_3\text{CO}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	2.0		1.3
$\text{CH}_3(\text{CH}_2)_3\text{O}-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	6.5		5.2
$\text{CH}_3(\text{CH}_2)_3\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	4.9		5.2
$(\text{CH}_3)_3\text{CO}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	4.6		2.1





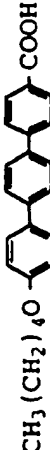

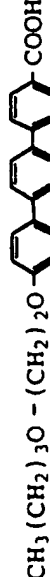
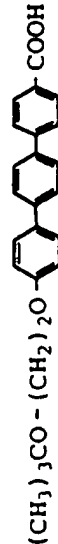
-46-

Table G (continued)

Carboxylic acid	mass (g)	mass (g) (2,4,5-trichlorophenyl ester)	mass (g) activated ester
$\text{CH}_3(\text{CH}_2)_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	3.3		1.5
$\text{C}_6\text{H}_5-\text{CH}_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	3.0		2.3
$\text{CH}_3(\text{CH}_2)_5-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	1.0		1.0
$\text{C}_6\text{H}_{11}-\text{CH}_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	2.0		0.8
$\text{C}_6\text{H}_{11}-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	7.2		0.8
$\text{C}_6\text{H}_{11}-\text{CH}_2-\text{N}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{COOH}$	7.5		7.3
$\text{C}_6\text{H}_5-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	2.0		0.6
$\text{CH}_3(\text{CH}_2)_3-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	1.1		0.6
$\text{CH}_3(\text{CH}_2)_5-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	4.6		3.5
$\text{CH}_3(\text{CH}_2)_5-\text{CH}=\text{C}(\text{trans})-\text{C}_6\text{H}_4-\text{COOH}$	1.2		0.5
$\text{CH}_3(\text{CH}_2)_7-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{COOH}$	11.1		13.2

-47-

Table G (continued)

Carboxylic acid	mass (g)	mass activated ester (2,4,5-trichlorophenyl ester)	mass (g)
	1.5		1.5
	8.3		13.2
	0.8		1.2
	3.3		4.8
	3.0		2.5
	2.3		3.9
	3.3		4.4
	1.3		1.9

-48-

Example 1N-Acylation of Cyclic Peptide Nuclei

5 The N-acyl cyclic peptide derivatives listed in
Table 3, below were prepared by dissolving Echinocandin B
(A-30912A) nucleus (compound of formula IB where R', R'',
and R''' are each methyl, RX¹ and RX² are each hydroxy, RY¹,
RY², RY³, and RY⁴ are each hydroxy, and R is hydroxy), and
10 the activated ester (2,4,5-trichlorophenol ester)
intermediates, described in Preparation 6, in 25-50 ml of
dimethylformamide. The resultant reaction mixture was
stirred for approximately 17-65 hours at room temperature
and then the solvent was removed in vacuo to provide a
residue. This residue was slurried in ether, collected by
15 filtration, washed with methylene chloride and then
dissolved in methanol or a 1:1 (v/v) acetonitrile/water
mixture. The resultant solution is subjected to reverse
phase HPLC (C18; eluent of 20-40% aqueous acetonitrile
containing 0.5% monobasic ammonium phosphate (w/v); 20
20 ml/min.; 230 nm). After removing the unreacted A30912A
nucleus, the desired product is eluted from the column
using an eluent of aqueous acetonitrile. The fractions
containing the desired product are combined and then
concentrated in vacuo or lyophilized to provide the desired
25 acylated nucleus. The product may be analyzed using
reverse phase HPLC (C18; 40% aqueous acetonitrile
containing 0.5% monobasic ammonium phosphate (w/v); 2
ml/min; 230 nm) or using MS (FAB).

30 For example, the compound depicted in Table 3II,
below, was prepared substantially according to this
procedure, using 348.1 g (60.2 mmol) of the A30912A
nucleus, 26.0 g (48.2 mmol) of the 2,4,5-trichlorophenol
ester of [(4"-pentyloxy)-1,1':4',1"-terphenyl]-4-
35 carboxylic acid in 8.5 liter of dimethylformamide. The
resultant reaction mixture was allowed to react for
approximately forty eight hours and then concentrated in

-49-

vacuo and purified using HPLC to provide 18 g of compound 3II.

MS (FAB): 1140.5103 (M^{+1}).

5 Compounds A-PP (listed in Table 3 below) were prepared substantially as described above.

-50-

Table 3

Ex. No.	R ₂	Ester (mg)	A30912A Nucleus (g)	Product (mg)	MS (FAB)	HPLC R _T (min)
3A		561	1.0	235	1072*	4.08
3B		576	1.0	294	1062*	4.46
3C		579	1.0	355	1086*	5.75
3D		634	1.0	359	1130*	5.79
3E		289	0.5	81	1083*	6.08
3F		594	1.0	295	1098*	6.44
3G		596	1.0	270	1100*	8.15
3H		596	1.0	359	1100*	9.13
3I		596	1.0	301	1100*	10.24
3J		629	1.0	180	1104**	--
3K		287	0.5	110	1082*	4.52
3L		593	1.0	307	1096*	7.28

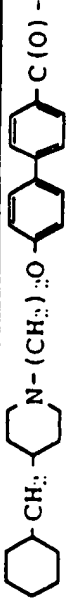
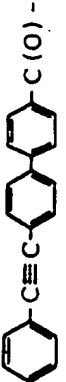

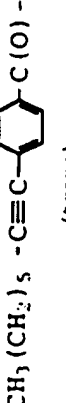



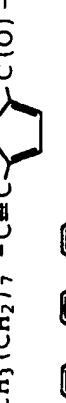

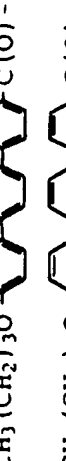
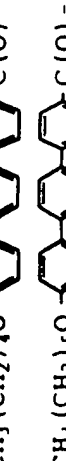
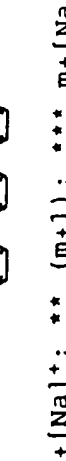
* (m-1)+[Na]⁺; ** (m+1); *** m+[Na]⁺; † m+1; †† m+[Li]⁺.

Table 3 (continued)

Ex. No.	R ₂	A30912A Ester (mg)	Nucleus (g)	Product (mg)	MS (FAB)	HPLC R _T (min)
3M		313	0.5	104	1124*	19.04
3N		579	1.0	293	1032*	6.14
3O		291	0.5	98	1088*	3.96
3P		616	1.0	341	1116*	11.56
3Q		2400	3.2	3000	1194.5213†	--
3R		1300	1.5	2400	1194.5247†	--
3S		4600	7.4	1300	1126.5025†	--
3T		683	1.0	384	1147**	1.92
3U		1490	2.0	116	1195**	2.06
3V		1000	1.2	194	1190***	2.41
3W		734	0.9	303	1202*	2.21
3X		810	1.0	230	1187**	2.52

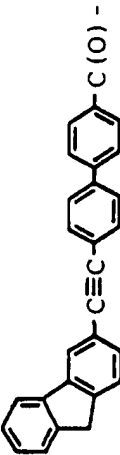
* (m-1)+[Na]⁺; ** (m+1); *** m+[Na]⁺; † m+1; †† m+[Li]⁺.

Table 3 (continued)

Ex. No.	R ₂	Ester (mg)	A30912A Nucleus (g)	Product (mg)	MS (FAB)	HPLC R _T (min)
3Y		750	1.0	126	1201**	3.50
3Z		596	1.0	190	1078**	6.30
3AA		571	1.0	295	1058**	7.91
3BB		511	1.0	322	1032*	5.10
3CC		514	1.0	287	1034*	6.14
3DD		546	1.0	285	1060*	12.48
3EE		501	1.0	218	1002**	2.53
3FF		534	1.0	215	1050***	7.59
3GG		566	1.0	81	1054**	3.89
3HH		4600	7.4	1300	1126.5025†	--
3II		2500	3.7	5100	1140.5103†	--
3JJ		3500	5.0	1400	1154.5343††	--

* (m-1)+[Na]⁺; ** (m+1); *** m+[Na]⁺; † m+1; †† m+[Li]⁺.

Table 3 (continued)

Ex- No.	R ₂	Ester (mg)	A30912A Nucleus (g)	Product (mg)	MS (FAB)	HPLC RT (min)
3KK	$\text{CH}_3(\text{CH}_2)_3\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{C}(\text{O})-$	4400	6.7	6500	1170.5234†	--
3LL	$(\text{CH}_3)_3\text{CO}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}_6\text{H}_4-\text{C}(\text{O})-$	1900	2.9	1400	1170.5261†	--
3MM	$\text{CH}_3(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{C}(\text{O})-$	5200	6.9	1400	1142.4951†	--
3NN	$(\text{CH}_3)_3\text{CO}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{C}(\text{O})-$	2100	2.5	2000	1200.5336†	--
3OO	$\text{CH}_3(\text{CH}_2)_3\text{O}-(\text{CH}_2)_2\text{O}-\text{C}_6\text{H}_4-\text{C}\equiv\text{C}-\text{C}_6\text{H}_4-\text{C}(\text{O})-$	5200	6.4	1100	1194.5282†	--
3PP		1800	2.6	200	1166.4758†	--

* (m-1)+[Na]⁺; ** (m+1); *** m+[Na]⁺; † m+1; †† m+[Li]⁺.

-54-

Example 2Dideoxycilofungin

To a suspension of 10.00 g (9.71 mmol) of
5 cilofungin in 100 ml of methylene chloride, was added a
solution of 96 ml (602 mmol) of triethylsilane in 50 ml of
methylene chloride. Then, a solution of 46.4 ml (602 mmol)
of trifluoroacetic acid in 50 ml of methylene chloride was
slowly added, over 15 minutes. The resultant solution was
10 stirred at room temperature for approximately two hours and
then concentrated *in vacuo* to provide a residue. This
residue was triturated with diethyl ether and then purified
using reverse phase HPLC (C18; gradient eluent of 10-20%
acetonitrile in water (v/v); 500 psi). The fractions
15 containing the desired compound were combined, concentrated
in vacuo, and then lyophilized from p-dioxane to provide
the desired titled compound.

Yield: 6.66 g (68.7%).

MS (FAB) for $C_{49}H_{72}N_7O_{15}$

20 Calc. 998.5086;

Found: 998.512.

UV: $\lambda(\text{EtOH})_{\text{nm}(\epsilon)}$ 202.60(61012), 256.20(18569).Example 3

25

Preparation of the dideoxy compound where R', R'', and R'''
are each methyl, R^{x1} and R^{x2} are each hydroxy, R^{y1}, R^{y2},
R^{y3}, R^{y4} are each hydroxy, R is hydroxy and R₂ is the acyl
group depicted in Table 3II

30

To a mixture of 5 g (4.4 mmol) of the compound
of Table 3II and 17 ml of trifluoroacetic acid in 250 ml of
methylene chloride, was added 35 ml of triethylsilane.
When the reaction was substantially complete, as indicated
by HPLC (C18, eluent of 55% acetonitrile; 2 ml/min; 280 nm;
35 R_T (starting material) = 4.19 min.; R_T (product) = 6.40
min.), the reaction mixture was concentrated *in vacuo* to
provide a solid. This solid was slurried in 100 ml of 50%
aqueous acetone and then dissolved by adjusting the pH of

-55-

the mixture to approximately pH 7. The resultant solution was poured into a large volume of water (approximately 1 liter) resulting in the precipitation of a white solid. This solid was isolated by filtration through a sintered glass funnel, washed with diethyl ether and then dried in vacuo at 55°C to provide 3.718 g of the titled compound. The funnel was washed with methanol to collect the remaining solid, which was dried in vacuo to provide an additional 0.154 g of the titled compound.

Yield: 3.872 g (79%).

MS (FAB): m/e 1108.7 (M)

HPLC: (eluent of 55% acetonitrile; 2 ml/min.; 280 nm):
R_T = 6.43 min.

15

Example 4Preparation of dideoxy cyclic hexapeptides

The following dideoxy compounds were prepared substantially in accordance with the procedure detailed in Example 3 using the designated amounts of a compound of formula IC where R', R'' and R''' are methyl, R^{x1} and R^{x2} are hydroxy, R^{y1}, R^{y2}, R^{y3} and R^{y4} are hydroxy, R is hydroxy and R₂ is as designated, triethylsilane (TES) and trifluoroacetic acid (TFA).

-55/1-

Table 4

Ex. No.	R ₂	formula IC (g)	TES (g)	TF A (g)	Yield (g)
A		0.500	0.256	0.251	0.095
B		0.500	2.47	2.42	0.063
C		0.500	2.63	2.57	0.392
D		2.00	9.49	9.72	1.47
E		0.500	3.50	3.44	0.291

-56-

Example 5

5 Preparation of the compound where R', R'', and R''' are each methyl, R^{x1} and R^{x2} are each hydroxy, R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy, R₀ is ethylphosphonate and R₂ is the acyl group depicted in Table 3II

A. Protection

10 To a solution of 2.00 g (1.75 mmol) of the compound of Table 3II in 50 ml of dioxane at room temperature, was added 25 ml (175 mmol) of 2-(trimethylsilyl)ethanol and p-toluenesulfonic acid (15 mol percent). The resultant reaction mixture was allowed
15 to react at room temperature for approximately three hours. When the reaction was substantially complete, as indicated by HPLC, the reaction was quenched with solid sodium bicarbonate and filtered. The desired titled compound was isolated from the filtrate using reverse phase HPLC (50% acetonitrile/50% water; 50 ml/min.; 280 nm).
20 Yield: 807 mg.

B. Formation of ethyl phosphonate derivative

25 To a cold (0°C) solution of 234.1 mg (0.191 mmol) of the titled compound of Example 5A in 10 ml of tetrahydrofuran, was added 0.21 ml (0.210 mmol) of a 1.0M solution of lithium bis(trimethylsilyl)amide (LHMDS) in hexanes, dropwise. The resultant mixture was allowed to stir for approximately twenty minutes followed by the
30 dropwise addition of 24.5 µl (0.223 mmol) of ethylphosphonic dichloride. The reaction mixture was stirred for approximately thirty minutes, quenched with 1 ml of water and then concentrated in vacuo to provide a white solid.
35 Yield: 42 mg.

-57-

HPLC (50% acetonitrile/50% water; 50 ml/min.; 280 nm):
R_T=1.37

C. Deprotection

5 To a mixture of 40.0 mg (0.028 mmol) of the
 titled compound of Example 5B in 20 ml of methylene
 chloride, was added 35 μ l (0.28 mmol) of boron trifluoride
 etherate, dropwise. The resultant reaction mixture was
 allowed to react for approximately thirty minutes and then
10 was quenched with 1.0 ml of water, resulting in the
 formation of a white precipitate. The reaction mixture was
 trituated with diethyl ether and then filtered to provide
 a light yellow solid.
 Yield: 12 mg.
15 MS (FAB): 1238.6 (M+Li).

Example 6

20 Preparation of the compound where R', R'', and R''' are each
 methyl, RX1 and RX2 are each hydroxy, RV1, RV2, RV3, RV4 are
 each hydroxy, R0 is methylphosphonate and R2 is the acyl
 group depicted in Table 3II

A. Formation of methyl phosphonate derivative

25 The subtitled compound was prepared
 substantially in accordance with the procedure detailed in
 Example 5B, above using using 271.1 mg (0.221 mmol) of the
 titled compound of Example 5A, 0.24 ml (0.24 mmol) of a
 1.0M solution of LHMDS in hexanes and 35.3 mg (0.266 mmol
30 of methylphosphonic dichloride in 10 ml of tetrahydrofuran
 to provide 40 mg of crude material that was used without
 further purification.

B. Deprotection

35 The subtitled compound was prepared
 substantially in accordance with the procedure detailed in
 Example 5C, using the compound isolated in Example 6A and

-58-

35 μ l of (0.28 mmol) of boron trifluoride etherate to provide a white/gray solid.
MS (FAB): 1200.5 (M-H₂O).

5

Example 7

Preparation of the compound where R', R'', and R''' are each methyl, R^{x1} and R^{x2} are each hydroxy, R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy, R₀ is phenylphosphonate and R₂ is the acyl group depicted in Table 3II

10

A. Formation of phenyl phosphonate derivative

The subtitled compound was prepared substantially in accordance with the procedure detailed in Example 5B, above, using using 359.6 mg (0.294 mmol) of the titled compound of Example 5A, 0.333 ml (0.323 mmol) of a 1.0M solution of LHMDs in hexanes and 50 μ l of phenylphosphonic dichloride to provide 52 mg of crude material which was used without further purification.

15

B. Deprotection

The subtitled compound was prepared substantially in accordance with the procedure detailed in Example 5C, using the compound isolated in Example 6A and 361 μ l of boron trifluoride etherate to provide a yellowish solid.

20

Yield: 32 mg.

MS (FAB): 1262.4 (M-H₂O).

25

Example 8

Preparation of the compound where R', R'', and R''' are each methyl, R^{x1} and R^{x2} are each hydrogen, R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy, R₀ is isopropylphosphate and R₂ is the acyl group depicted in Table 3II

30

A. Isopropylidichlorophosphate

To a solution of 1.55 ml (16.6 mmol) of phosphorous oxychloride in 5 ml of carbon tetrachloride,

-59-

was added 1.28 ml (16.6 mmol) of isopropanol, under nitrogen, resulting in an increase in temperature. An ice bath was used as necessary to keep the temperature between 20°C and 35°C. The reaction mixture was allowed to react for approximately seven hours at room temperature, under nitrogen. The resultant mixture was concentrated in vacuo to provide a clear oil.
Yield: 1.9 g (65%).

10 B. Formation of isopropyl phosphate derivative

To a cold (0°C) solution containing 0.5 g (0.45 mmol) of the titled compound of Example 3 in 10 ml of tetrahydrofuran and 54 µl (0.54 mmol) of lithium trimethylsilanolate (LiOTMS), was added 88 mg (0.5 mmol) of the subtitled compound of Example 8A. The resultant reaction mixture was stirred for approximately ten minutes. Additional LiOTMS was added to the reaction mixture until the pH of the mixture was basic. When the reaction was substantially complete, as indicated by HPLC, the reaction was quenched with water, stirred for approximately one hour and then concentrated in vacuo to provide a yellow solid. This solid was purified using HPLC (eluent of 45% acetonitrile/45% water/10% trifluoroacetic acid (1% aqueous solution)) to provide a white solid.
Yield: 105 mg.
MS (FAB): 1230.4 (M⁺)

Example 9

30 Preparation of the compound where R', R'', and R''' are each methyl, R^{x1} and R^{x2} are each hydrogen, R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy, R₀ is butylphosphate and R₂ is the acyl group depicted in Table III

35 A. Butyldichlorophosphate

The desired subtitled compound was prepared substantially in accordance with the procedure detailed in Example 8A, using 1.25 ml (13.5 mmol) of phosphorous

-60-

oxychloride, 1 g (13.5 mmol) of butanol in 5 ml of carbon tetrachloride to provide a colorless oil.

Yield: 2.3 g (89%).

5 B. Formation of butyl phosphate derivative

The desired subtitled compound was prepared substantially in accordance with the procedure detailed in Example 8B, using 0.5 g (0.45 mmol) of the titled compound of Example 3, LiOTMS and 95 mg (0.50 mmol) of the subtitled
10 compound of Example 9A to provide a yellow solid. This solid was purified using reverse phase HPLC (gradient eluent of 45% acetonitrile/45% water/10% (1% aqueous) trifluoroacetic acid → 50% acetonitrile/40% water/10% (1% aqueous) trifluoroacetic acid) to provide a 126 mg of the
15 desired compound.

MS (FAB): 1244.4 (M⁺)

Example 10

20 Preparation of the compound where R', R'', and R''' are each methyl, R^{x1} and R^{x2} are each hydrogen, R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy, R₀ is methylphosphate and R₂ is the acyl group depicted in Table 3II

To a mixture of 500 mg (0.45 mmol) of the titled
25 compound of Example 3 and 0.5 mL (0.5 mmol) of LiOTMS in 5 ml of tetrahydrofuran, was added 0.075 ml (0.75 mmol) of methyl dichlorophosphate resulting in the dissolution of solid material. The reaction was monitored by HPLC (eluent of 70% acetonitrile; 2 ml/min.; 280 nm) resulting in the
30 addition of an additional 0.7 ml of LiOTMS and 0.02 ml of methyl dichlorophosphate to the reaction mixture. When the reaction was substantially complete, as indicated by HPLC (eluent of 50% acetonitrile containing 0.1% trifluoroacetic acid; 2 ml/min.; 280 nm), the desired compound was isolated
35 using HPLC (eluent of 40% acetonitrile containing 0.1% trifluoroacetic acid; 90 ml/min.; 280 nm). The fractions containing the desired compound were combined and concentrated in vacuo to provide 232 mg of the titled

-61-

compound (81% pure by HPLC). This compound was purified using HPLC (step gradient eluent of 30% → 35% → 40% acetonitrile containing 0.1% trifluoroacetic acid; 90 ml/min.; 280 nm) to provide 109 mg of the titled compound (94% pure).

5 MS (FAB): m/e 1202.6 (M⁺).

Example 11

10 Preparation of the compound where R', R'', and R''' are each methyl. R^{x1} and R^{x2} are each hydrogen. R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy. R₀ is hexylphosphonate and R₂ is the acyl group depicted in Table 3II

To a cold (0°C) mixture of 1 g (0.902 mmol) of the titled compound of Example 3 in 5 ml of tetrahydrofuran, was added 1.35 ml of a 1M solution of LHMDS in tetrahydrofuran (1.35 mmol), dropwise. After stirring the resulting mixture for approximately thirty minutes, 309 µl (1.804 mmol) of hexyldichlorophosphate was added and the reaction mixture was allowed to warm to room temperature, followed by the addition of water. The resultant reaction mixture was reduced to dryness in vacuo to provide the desired titled compound.

15 20

Yield: 102 mg.

25 MS (FAB): Calcd: 1262.5978 (M⁺Li);
Found: 1262.5979 (M⁺Li).

Example 12

30 Preparation of the compound where R', R'', and R''' are each methyl. R^{x1} and R^{x2} are each hydrogen. R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy. R₀ is methylphosphonate and R₂ is the acyl group depicted in Table 3II

The titled compound was prepared substantially in accordance with the procedure detailed in Example 11, using 221.9 mg (0.200 mmol) of the titled compound of Example 3 and 0.240 ml of a 1M solution of LHMDS in hexanes (0.240 mmol) and 35 mg (0.26 mmol) of methyl phosphonic dichloride in 20 ml of tetrahydrofuran.

35

-62-

Yield: 44 mg.

MS (FAB): 1192.2 (M+Li)

Example 13

Preparation of the compound where R', R'', and R''' are each methyl, R^{x1} and R^{x2} are each hydroxy, R^{y1}, R^{y2}, R^{y3}, R^{y4} are each hydroxy, R₀ is methylphosphate and R₂ is the acyl group depicted in Table 3II

A. Formation of methyl phosphate derivative

To a cold (0°C) mixture of 400 mg (0.32 mmol) of the subtitled compound of Example 5A and 0.36 mL (0.36 mmol) of LiOTMS (1M solution in methylene chloride) in 5 ml of tetrahydrofuran, under nitrogen, was added 0.04 ml (0.4 mmol) of methyl dichlorophosphate. When the reaction was substantially complete, as indicated by HPLC (eluent of 80% acetonitrile; 2 ml/min.; 280 nm), several aliquots of lithium hydroxide were added to the mixture. The desired compound was isolated using HPLC (eluent of 60% acetonitrile containing 0.1% trifluoroacetic acid; 90 ml/min.; 280 nm). The fractions containing the desired compound were combined and concentrated *in vacuo* to provide 129.8 mg of the subtitled compound.

Yield: 30%.

HPLC (eluent of 65% acetonitrile containing 0.1% trifluoroacetic acid; 2 ml/min.; 280 nm): R_T=4.28 min.

B. Deprotection

To a cold (0°C) mixture of 118 mg (0.09 mmol) of the subtitled compound of Example 13A in 3 ml of methylene chloride, was added 35 µl (0.28 mmol) of boron trifluoride etherate. The resultant reaction mixture was allowed to react for approximately ten minutes and then was quenched with several drops of water, resulting in the formation of a white precipitate. The reaction mixture was concentrated *in vacuo* to provide a residue. This residue was slurried in diethyl ether and then filtered to provide a solid which

-63-

was dried in vacuo. The resultant product was determined to be 92% pure using HPLC (eluent of 50% acetonitrile containing 1% trifluoroacetic acid; 2 ml/min.; 280 nm; $R_T=3.92$ min)

5 Yield: 88 mg (80%).
MS (FAB): 1216.4 (M-H₂O)
1256.3 (M+Na).

Example 14

10 Preparation of the compound where R', R'', and R''' are each methyl, RX1 and RX2 are each hydroxy, RV1, RV2, RV3, RV4 are each hydroxy, R0 is ethylphosphate and R2 is the acyl group depicted in Table 3II

15

A. Formation of ethyl phosphate derivative

To a cold (0°C) mixture of 400 mg (0.32 mmol) of the subtitled compound of Example 5A and 0.36 mL (0.36 mmol) of LiOTMS (1M solution in methylene chloride) in 5 ml of tetrahydrofuran, under nitrogen, was added 0.47 ml (0.4 mmol) of ethyl dichlorophosphate. When the reaction was substantially complete, as indicated by HPLC (eluent of 80% acetonitrile; 2 ml/min.; 280 nm), approximately 0.5 ml of water was added to the mixture, dropwise. The desired compound was isolated using HPLC (eluent of 60% acetonitrile containing 0.1% trifluoroacetic acid; 90 ml/min.; 280 nm). The fractions containing the desired compound were combined and concentrated in vacuo to provide a residue. This residue was slurried in diethyl ether and then filtered to provide 67.8 mg of a solid. This resultant product was determined to be 71% pure using HPLC (eluent of 65% acetonitrile containing 0.1% trifluoroacetic acid; 2 ml/min.; 280 nm; $R_T=5.99$ min.).

35

B. Deprotection

The desired titled compound was prepared substantially in accordance with the procedure detailed in Example 13B, using 67.8 mg of the subtitled compound of

-64-

Example 14A and 0.1 ml (0.81 mmol) of the boron trifluoride etherate in methylene chloride. The resultant product was determined to be 89% pure using HPLC (eluent of 50% acetonitrile containing 0.1% trifluoroacetic acid; 2 ml/min.; 280 nm; R_T =5.85 min.)
Yield: 51 mg.
MS (FAB): 1230.3 (M-H₂O).

The compounds of formula I have improved properties over the previously known N-acyl cyclic peptide antifungal compounds. For example, the present compounds have increased oral bioavailability, an important property for a systemic antifungal compound. In addition, the present compounds have enhanced antifungal activity and enhanced water solubility, relative to previously known compounds.

The compounds of formula I exhibit antifungal and antiparasitic activity. For example, the compounds of formula I inhibit the growth of various infectious fungi including Candida spp. such as C. albicans, C. parapsilosis, C. krusei, C. glabrata, or C. tropicalis, C. lusitaniae; Torulopus spp. such as T. glabrata; Aspergillus spp. such as A. fumigatus; Histoplasma spp. such as H. capsulatum; Cryptococcus spp. such as C. neoformans; Blastomyces spp. such as B. dermatitidis; Fusarium spp., Trichophyton spp., Pseudallescheria boydii, Coccidioides immitis, Sporothrix schenckii and the like.

Antifungal activity of a test compound is determined *in vitro* by obtaining the minimum inhibitory concentration (MIC) of the compound using a standard agar dilution test or a disc-diffusion test. The compound is then tested *in vivo* (in mice) to determine the effective dose of the test compound for controlling a systemic fungal infection.

Accordingly, the following compounds were tested for antifungal activity against C. albicans.

-65-

Table 5
Minimal inhibitory concentration against C. albicans

	<u>Example No.</u>	<u>MIC (μg/ml)</u>
5	5C	0.312
	6B	1.25
	7B	2.5
	8B	>80
	9B	>80
10	10	0.312
	11	1.25
	12	0.039
	13B	0.625
	14B	0.625

In addition, the effective dose of the following compounds for controlling a systemic fungal infection (C. albicans) was tested in vivo (mice).

20

Table 5
ED₅₀ (mouse)

	<u>Example No.</u>	<u>ED₅₀ (mg/kg)</u>
25	5C	1.25
	6B	1.58
	7B	>2.5
	8B	1.02
	9B	0.39
	10	0.47
30	11	0.312
	12	0.79
	13B	1.86
	14B	1.38

35

The compounds of the invention also inhibit the growth of certain organisms primarily responsible for opportunistic infections in immunosuppressed individuals.

-66-

For example the compounds of the invention inhibit the growth of Pneumocystis carinii the causative organism of pneumocystis pneumonia (PCP) in AIDS and other immunocompromised patients. Other protozoans that are inhibited by compounds of formula I include Plasmodium spp., Leishmania spp., Trypanosoma spp., Cryptosporidium spp., Isospora spp., Cyclospora spp., Trichomonas spp., Microsporidiosis spp. and the like.

The compounds of formula I are active in vitro and in vivo and are useful in combating either systemic fungal infections or fungal skin infections. Accordingly, the present invention provides a method of inhibiting fungal activity comprising contacting a compound of formula I, or a pharmaceutically acceptable salt thereof, with a fungus. A preferred method includes inhibiting *Candida albicans* or *Aspergillus fumigatis* activity. The present invention further provides a method of treating a fungal infection which comprises administering an effective amount of a compound of formula I, or a pharmaceutically acceptable salt thereof, to a host in need of such treatment. A preferred method includes treating a *Candida albicans* or *Aspergillus fumigatis* infection.

With respect to antifungal activity, the term "effective amount," means an amount of a compound of the present invention which is capable of inhibiting fungal activity. The dose administered will vary depending on such factors as the nature and severity of the infection, the age and general health of the host and the tolerance of the host to the antifungal agent. The particular dose regimen likewise may vary according to such factors and may be given in a single daily dose or in multiple doses during the day. The regimen may last from about 2-3 days to about 2-3 weeks or longer. A typical daily dose (administered in single or divided doses) will contain a dosage level of from about 0.01 mg/kg to about 100 mg/kg of body weight of an active compound of this invention. Preferred daily

-67-

doses generally will be from about 0.1 mg/kg to about 60 mg/kg and ideally from about 2.5 mg/kg to about 40 mg/kg.

The present invention also provides pharmaceutical formulations useful for administering the antifungal compounds of the invention. Accordingly, the present invention also provides a pharmaceutical formulation comprising one or more pharmaceutically acceptable carriers, diluents or excipients and a compound of claim 1. The active ingredient in such formulations comprises from 0.1% to 99.9% by weight of the formulation, more generally from about 10% to about 30% by weight. By "pharmaceutically acceptable" it is meant that the carrier, diluent or excipient is compatible with the other ingredients of the formulation and not deleterious to the recipient thereof.

A compound of formula I may be administered parenterally, for example using intramuscular, subcutaneous, or intra-peritoneal injection, nasal, or oral means. In addition to these methods of administration, a compound of formula I may be applied topically for skin infections.

For parenteral administration the formulation comprises a compound of formula I and a physiologically acceptable diluent such as deionized water, physiological saline, 5% dextrose and other commonly used diluents. The formulation may contain a solubilizing agent such as a polyethylene glycol or polypropylene glycol or other known solubilizing agent. Such formulations may be made up in sterile vials containing the antifungal and excipient in a dry powder or lyophilized powder form. Prior to use, a physiologically acceptable diluent is added and the solution withdrawn via syringe for administration to the patient.

The present pharmaceutical formulations are prepared by known procedures using known and readily available ingredients. In making the compositions of the present invention, the active ingredient will generally be

-68-

admixed with a carrier, or diluted by a carrier, or enclosed within a carrier which may be in the form of a capsule, sachet, paper or other container. When the carrier serves as a diluent, it may be a solid, semi-solid or liquid material which acts as a vehicle, excipient or medium for the active ingredient. Thus, the compositions can be in the form of tablets, pills, powders, lozenges, sachets, cachets, elixirs, suspensions, emulsions, solutions, syrups, aerosols, (as a solid or in a liquid medium), ointments containing, for example, up to 10% by weight of the active compound, soft and hard gelatin capsules, suppositories, sterile injectable solutions, sterile packaged powders and the like.

For oral administration, the antifungal compound is filled into gelatin capsules or formed into tablets. Such tablets may also contain a binding agent, a dispersant or other suitable excipients suitable for preparing a proper size tablet for the dosage and particular antifungal compound of the formula I. For pediatric or geriatric use the antifungal compound may be formulated into a flavored liquid suspension, solution or emulsion. A preferred oral formulation is linoleic acid, cremophor RH-60 and water and preferably in the amount (by volume) of 8% linoleic acid, 5% cremophor RH-60, 87% sterile water and a compound of formula I in an amount of from about 2.5 to about 40 mg/ml.

For topical use the antifungal compound may be formulated with a dry powder for application to the skin surface or it may be formulated in a liquid formulation comprising a solubilizing aqueous liquid or non-aqueous liquid, e.g., an alcohol or glycol.

The following formulation examples are illustrative only and are not intended to limit the scope of the invention in any way. The term "active ingredient" means a compound according to formula I or a pharmaceutically acceptable salt thereof.

-69-

Formulation 1

Hard gelatin capsules are prepared using the following ingredients:

5		Quantity
		<u>(mg/capsule)</u>
	Active ingredient	250
	Starch, dried	200
10	Magnesium stearate	<u>10</u>
	Total	460 mg

Formulation 2

15 A tablet is prepared using the ingredients below:

		Quantity
		<u>(mg/capsule)</u>
20	Active ingredient	250
	Cellulose, microcrystalline	400
	Silicon dioxide, fumed	10
	Stearic acid	<u>5</u>
	Total	665 mg

25

The components are blended and compressed to form tablets each weighing 665 mg.

Formulation 3

30 An aerosol solution is prepared containing the following components:

		<u>Weight</u>
35	Active ingredient	0.25
	Methanol	25.75
	Propellant 22	

-70-

(Chlorodifluoromethane)	<u>74.00</u>
Total	100.00

5 The active compound is mixed with ethanol and
the mixture added to a portion of the propellant 22, cooled
to
-30°C and transferred to a filling device. The required
amount is then fed to a stainless steel container and
diluted with the remainder of the propellant. The valve
10 units are then fitted to the container.

Formulation 4

Tablets, each containing 60 mg of active
ingredient, are made as follows:

15 Active ingredient	60 mg
Starch	45 mg
Microcrystalline cellulose	35 mg
Polyvinylpyrrolidone	
20 (as 10% solution in water)	4 mg
Sodium carboxymethyl starch	4.5 mg
Magnesium stearate	0.5 mg
Talc	<u>1 mg</u>
Total	150 mg

25

The active ingredient, starch and cellulose are
passed through a No. 45 mesh U.S. sieve and mixed
thoroughly. The aqueous solution containing polyvinyl-
pyrrolidone is mixed with the resultant powder, and the
30 mixture then is passed through a No. 14 mesh U.S. sieve.
The granules so produced are dried at 50°C and passed
through a No. 18 mesh U.S. sieve. The sodium carboxymethyl
starch, magnesium stearate and talc, previously passed
through a No. 60 mesh U.S. sieve, are then added to the
35 granules which, after mixing, are compressed on a tablet
machine to yield tablets each weighing 150 mg.

-71-

Formulation 5

Capsules, each containing 80 mg of active ingredient, are made as follows:

5	Active ingredient	80 mg
	Starch	59 mg
	Microcrystalline cellulose	59 mg
	Magnesium stearate	<u>2 mg</u>
	Total	200 mg

10 The active ingredient, cellulose, starch and magnesium stearate are blended, passed through a No. 45 mesh U.S. sieve, and filled into hard gelatin capsules in 200 mg quantities.

15

Formulation 6

Suppositories, each containing 225 mg of active ingredient, are made as follows:

	Active ingredient	225 mg
20	Saturated fatty acid glycerides	<u>2,000 mg</u>
	Total	2,225 mg

25 The active ingredient is passed through a No. 60 mesh U.S. sieve and suspended in the saturated fatty acid glycerides previously melted using the minimum heat necessary. The mixture is then poured into a suppository mold of nominal 2 g capacity and allowed to cool.

Formulation 7

30 Suspensions, each containing 50 mg of active ingredient per 5 ml dose, are made as follows:

	Active ingredient	50 mg
	Sodium carboxymethyl cellulose	50 mg
35	Syrup	1.25 ml
	Benzoic acid solution	0.10 ml
	Flavor	q.v.

-72-

Color	q.v.
Purified water to total	5 ml

5 The active ingredient is passed through a No. 45 mesh U.S. sieve and mixed with the sodium carboxymethyl cellulose and syrup to form a smooth paste. The benzoic acid solution, flavor and color are diluted with a portion of the water and added, with stirring. Sufficient water is then added to produce the required volume.

10

Formulation 8

An intravenous formulation may be prepared as follows:

15

Active ingredient	100 mg
Isotonic saline	1,000 ml

20 The solution of the above ingredients generally is administered intravenously to a subject at a rate of 1 ml per minute.

The present invention further provides a method for treating or preventing the onset of Pneumocystis pneumonia in a host susceptible to Pneumocystis pneumonia which comprises administering an effective amount of a compound of formula I, or a pharmaceutically acceptable salt thereof, to a host in need of such treatment. The compounds of formula I can be used prophylactically to prevent the onset of the infection which is caused by the organism Pneumocystis carinii, or alternatively they can be used to treat a host that has been infected with Pneumocystis carinii. A compound of formula I may be administered parenterally, for example using intramuscular, intravenous or intra-peritoneal injection, orally or by inhaling directly into the airways of the lungs. A preferred mode of administration is inhalation of an aerosol spray formulation of a compound of formula I.

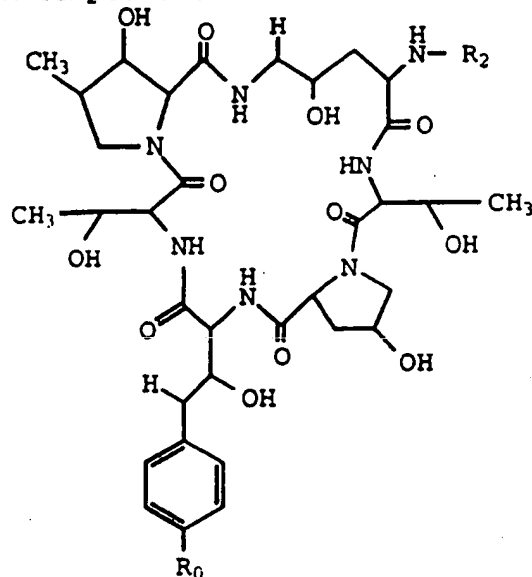
-73-

With respect to antiparasitic activity, the term "effective amount," means an amount of a compound of the present invention which is capable of inhibiting parasitic activity. An effective amount of the compound of formula I
5 is from about 3 mg/kg of patient body weight to about 100 mg/kg. The amount administered may be in a single daily dose or multiple doses of, for example, two, three or four times daily throughout the treatment regimen. The amount of the individual doses, the route of delivery, the
10 frequency of dosing and the term of therapy will vary according to such factors as the intensity and extent of infection, the age and general health of the patient, the response of the patient to therapy and how well the patient tolerates the drug. It is known that Pneumocystis
15 pneumonia infections in AIDS patients are highly refractory owing to the nature of the infection. For example, in severe, advanced infections the luminal surface of the air passages becomes clogged with infectious matter and extensive parasite development occurs in lung tissue. A
20 patient with an advanced infection will accordingly require higher doses for longer periods of time. In contrast, immune deficient patients who are not severely infected and who are susceptible to Pneumocystis pneumonia can be treated with lower and less frequent prophylactic doses.

-74-

CLAIMS

1. A compound of formula I:



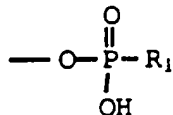
wherein:

R' is hydrogen, methyl or $\text{NH}_2\text{C}(\text{O})\text{CH}_2-$;

R'' and R''' are independently methyl or hydrogen;

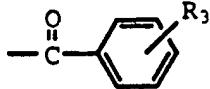
R^{x1}, R^{x2}, R^{y1}, R^{y2}, R^{y3}, and R^{y4} are independently hydroxy or hydrogen;

R₀ is a group of the formula



R₁ is C₁-C₆ alkyl, C₁-C₆ alkoxy, phenyl, p-halo-phenyl, p-nitrophenyl, phenoxy, benzyl, p-halo-benzyl, or p-nitro-benzyl;

- I) R₂ is a group of the formula



where:

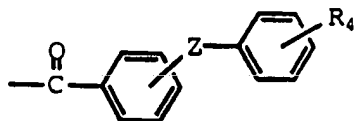
- A) R₃ is C₁-C₁₂ alkyl, C₁-C₆ alkoxy or quinolyl;
 B) R₃ is $-\text{O}-(\text{CH}_2)_m-[\text{O}-(\text{CH}_2)_n]_p-\text{O}-(\text{C}_1\text{-C}_{12} \text{ alkyl})$;
 m and n are independently 2, 3 or 4;

-75-

p is 0 or 1; or

C) R_3 is $-Y-(C_1-C_{12} \text{ alkyl})$;Y is $-C\equiv C-$ or $-CH=CH-$; orD) R_3 is $-O-(CH_2)_q-G$;

q is 2, 3 or 4;

G is C_7-C_{10} bicycloalkyl or C_7-C_{14} tricycloalkyl; orII) R_2 is a group of the formula

where:

Z is $-O-$, $-C\equiv C-$, $-CH=CH-$, $-CH_2-CH_2-$, $-CH_2-$, or a bond;

A) R_4 is hydrogen, C_1-C_{12} alkyl, C_1-C_{12} substituted alkyl, C_2-C_{12} alkenyl, C_2-C_{12} substituted alkenyl, C_2-C_{12} alkynyl, C_2-C_{12} substituted alkynyl, C_1-C_{12} alkoxy, C_3-C_{12} cycloalkyl, C_7-C_{10} bicycloalkyl, C_7-C_{14} tricycloalkyl, C_3-C_{12} cycloalkoxy, naphthyl, pyridyl, thienyl, benzothienyl, quinolyl or phenyl; or

B) R_4 is phenyl substituted by amino, C_1-C_{12} alkylthio, halo, C_1-C_{12} alkyl, C_2-C_{12} alkenyl, C_2-C_{12} alkynyl, C_1-C_{12} substituted alkyl, C_2-C_{12} substituted alkenyl, C_2-C_{12} substituted alkynyl, C_1-C_{12} alkoxy, trifluoromethyl, phenyl, substituted phenyl, or phenyl substituted with a group of the formula $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$ where m, n and p are as defined above; or

C) R_4 is C_1-C_{12} alkoxy substituted with halo, C_3-C_{12} cycloalkyl, C_7-C_{10} bicycloalkyl, C_7-C_{14} tricycloalkyl, C_1-C_6 alkoxy, C_2-C_{12} alkynyl, amino, C_1-C_4 alkylamino, di(C_1-C_4 alkyl)amino, formamido, C_2-C_{12} alkanoylamino, or phenyl substituted with a group of the formula $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$ where m, n and p are as defined above; or

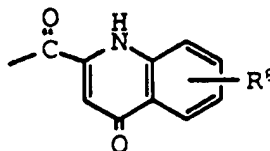
-76-

D) R_4 is $-O-(CH_2)_r-W-R_5$;
 r is 2, 3 or 4;
 W is pyrrolidino, piperidino or piperazino;
 R_5 is hydrogen, C_1 - C_{12} alkyl, C_3 - C_{12} cycloalkyl, benzyl or C_3 - C_{12} cycloalkylmethyl; or

E) R_4 is $-Y^1-R_6$;
 Y^1 is $-C\equiv C-$ or $-CH=CH-$;
 R_6 is C_3 - C_{12} cycloalkyl, C_7 - C_{10} bicycloalkyl, C_7 - C_{14} tricycloalkyl, C_3 - C_{12} cycloalkenyl, naphthyl, benzothiazolyl, thienyl, indanyl, fluorenyl, or phenyl substituted with C_1 - C_{12} alkylthio, C_2 - C_{12} alkenyl, C_2 - C_{12} alkynyl, halo(C_1 - C_6 alkoxy) or a group of the formula $-O-(CH_2)_r-W-R_5$ where r , W and R_5 are as defined above; or
 R_6 is phenyl substituted with a group of the formula $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$ where m , n and p are as defined above; or

F) R_4 is C_1 - C_{12} alkoxy substituted with a group of the formula $-NHC(O)R_7$;
 R_7 is C_1 - C_6 alkoxy, or phenyl(C_1 - C_6 alkoxy); or

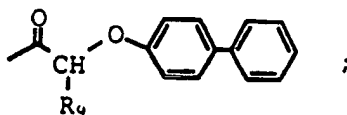
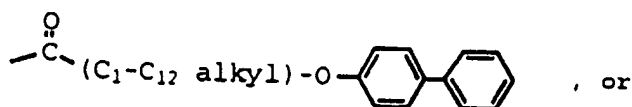
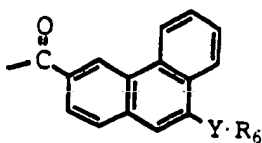
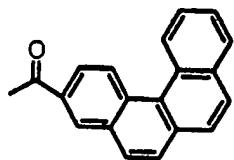
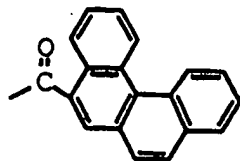
III) R_2 is a group of the formula



where R^8 is C_1 - C_{12} alkoxy or a group of the formula $-O-(CH_2)_m-[O-(CH_2)_n]_p-O-(C_1-C_{12} \text{ alkyl})$ where m , n and p are as defined above; or

IV) R_2 is a group of the formula

-77-



where:

Y and R₆ are as defined above;

R₉ is phenyl, C₁-C₁₂ alkyl, or C₁-C₁₂ alkoxy; or

V) R₂ is naphthoyl substituted with R₄ where R₄ is as defined above;

or a pharmaceutically acceptable salt thereof.

2. A compound according to claim 1 where:

R', R'', and R''' are each methyl;

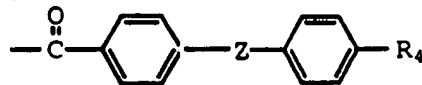
RY¹, RY², RY³, RY⁴ are each hydroxy;

RX¹ and RX² are hydrogen;

or a pharmaceutically acceptable salt thereof.

-78-

3. A compound according to claim 2 where:
 R_2 is a group of the formula



where:

Z is $\text{---C}\equiv\text{C---}$ or a bond;

A) R_4 is hydrogen, $\text{C}_2\text{---C}_{12}$ alkynyl, $\text{C}_2\text{---C}_{12}$ substituted alkynyl, $\text{C}_1\text{---C}_{12}$ alkoxy, $\text{C}_3\text{---C}_{12}$ cycloalkoxy, or phenyl; or

B) R_4 is phenyl substituted by $\text{C}_1\text{---C}_{12}$ alkoxy, or a group of the formula $\text{---O---(CH}_2\text{)}_2\text{---O---(C}_1\text{---C}_6\text{ alkyl)}$; or

C) R_4 is $\text{C}_1\text{---C}_{12}$ alkoxy substituted with $\text{C}_3\text{---C}_{12}$ cycloalkyl, $\text{C}_7\text{---C}_{14}$ tricycloalkyl, $\text{C}_1\text{---C}_6$ alkoxy, amino, di($\text{C}_1\text{---C}_4$ alkyl)amino, formamido, or phenyl substituted with a group of the formula $\text{---O---(CH}_2\text{)}_2\text{---O---(C}_1\text{---C}_6\text{ alkyl)}$; or

D) R_4 is $\text{---O---(CH}_2\text{)}_r\text{---W---R}_5$;
 r is 2 or 3;
 W is piperidino;
 R_5 is hydrogen, $\text{C}_1\text{---C}_{12}$ alkyl, $\text{C}_3\text{---C}_{12}$ cycloalkyl, benzyl or $\text{C}_3\text{---C}_{12}$ cycloalkylmethyl; or

E) R_4 is $\text{---Y}^1\text{---R}_6$;
 Y^1 is $\text{---C}\equiv\text{C---}$;

R_6 is phenyl substituted with $\text{C}_1\text{---C}_{12}$ alkylthio, $\text{C}_2\text{---C}_{12}$ alkenyl, $\text{C}_2\text{---C}_{12}$ alkynyl, halo($\text{C}_1\text{---C}_6$ alkoxy);
 or R_6 is phenyl substituted with a group of the formula $\text{---O---(CH}_2\text{)}_r\text{---W---R}_5$ where r , W and R_5 are as defined above;

or R_6 is phenyl substituted with a group of the formula $\text{---O---(CH}_2\text{)}_2\text{---O---(C}_1\text{---C}_6\text{ alkyl)}$;

-79-

F) R_4 is C_1 - C_{12} alkoxy substituted with a group of the formula $-NHC(O)R_7$;

R_7 is C_1 - C_6 alkoxy, or phenyl (C_1 - C_6 alkoxy); or a pharmaceutically acceptable salt thereof.

4. A compound according to claim 3 where R_1 is C_1 - C_4 alkyl, C_1 - C_4 alkoxy, phenyl, p-chloro-phenyl, p-bromo-phenyl, or p-nitro-phenyl, benzyl, p-chloro-benzyl, p-bromo-benzyl, or p-nitro-benzyl; or a pharmaceutically acceptable salt thereof.

5. A compound according to claim 4 where R_1 is methyl, ethyl, methoxy, ethoxy, phenyl, benzyl; or a pharmaceutically acceptable salt thereof.

6. The compound according to claim 5 where Z is a bond; R_4 is phenyl substituted by n-pentoxy; and R_1 is methyl; or a pharmaceutically acceptable salt thereof.

7. A pharmaceutical formulation comprising a compound of formula I or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 6, associated with one or more pharmaceutically acceptable carriers, diluents or excipients therefor.

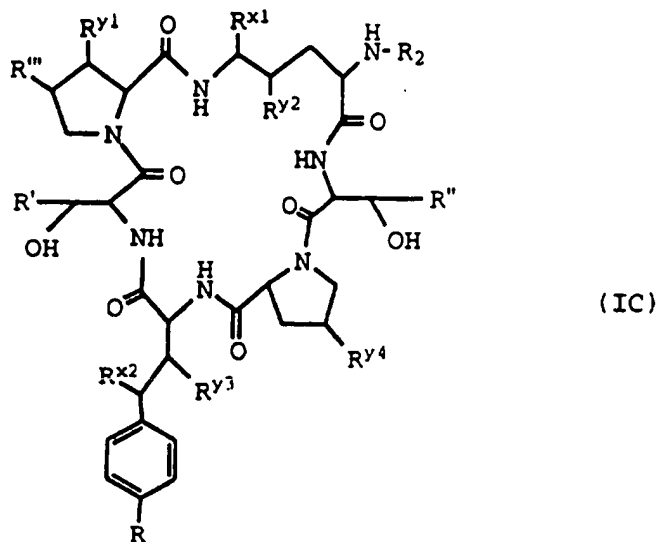
8. A compound of formula I, or a pharmaceutically acceptable salt thereof, as claimed in any of claims 1 to 6 for use as a pharmaceutical.

9. A method of treating a fungal infection in a mammal which comprises administering to such a mammal a compound of formula I, or a pharmaceutically acceptable salt thereof, as claimed in any one of claims 1 to 6.

10. A process for preparing a compound of formula I, or a pharmaceutically acceptable salt thereof as claimed in

-80-

any of claims 1 to 6, comprising reacting a compound of formula IC



where R', R'', R''', Rx1, Rx2, Ry1, Ry2, Ry3, Ry4 and R₂ are as defined in claim 1;

with a substituted C₁-C₆ alkyl phosphoric acid, phenyl phosphoric acid, substituted C₁-C₆ alkyl phosphate or phenyl phosphate;

followed, if desired, by forming a pharmaceutically acceptable salt thereof.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/04543

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : A61K 38/12; C07K 7/56

US CL : 514/11; 530/317

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 514/11; 530/317

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0561639 A1 (EIL LILLY AND COMPANY) 22 September 1993, see pages 2 and 34.	1-10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* "A"	Special categories of cited documents: document defining the general state of the art which is not considered to be of particular relevance	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E"	earlier document published on or after the international filing date	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O"	document referring to an oral disclosure, use, exhibition or other means	"Z"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

08 JULY 1996

Date of mailing of the international search report

15.07.96

Name and mailing address of the ISA/US
Commissioner of Patents and Trademarks
Box PCT
Washington, D.C. 20231

Facsimile No. (703) 305-3230

Authorized officer

HOWARD E. SCHAIN

Telephone No. (703) 308-0196